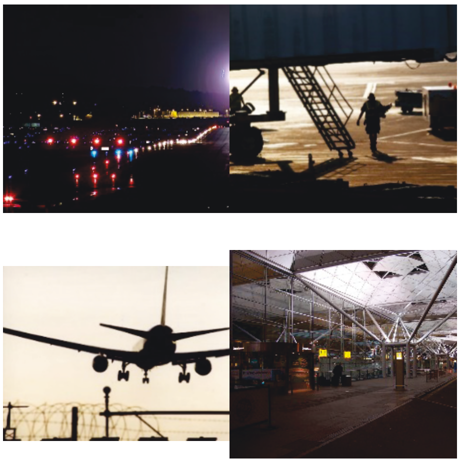
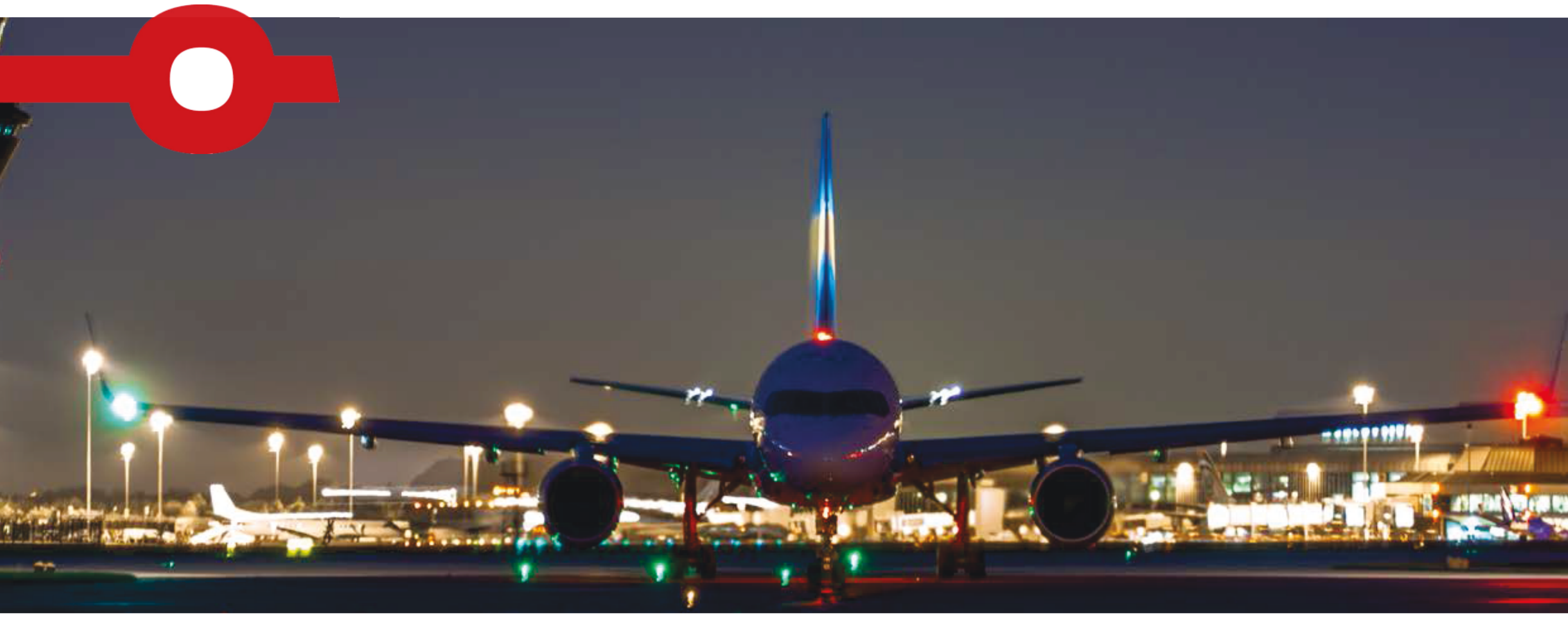
Aviation Research Study

15/08/2017



ECONOMIC IMPACTS OF NIGHT FLIGHTS: RESEARCH STUDY

FINAL REPORT



ECONOMIC IMPACTS OF NIGHT FLIGHTS: RESEARCH STUDY

FINAL REPORT

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABSTRACT

Aircraft noise is an important area of public concern. As part of its review of the current night flight regime at Heathrow, Gatwick and Stansted, the Department for Transport commissioned SYSTRA to undertake a research study on the “Economic Impacts of night flights”.

This study seeks to break new ground in quantifying the economic impacts of possible changes to the night flight regime at these airports. Its key outputs are flexible models for each airport which can be used by the Department to estimate the economic impacts on airports, airlines, passengers and the public accounts from a combination of any potential changes that could be considered to the airport’s movement limits and noise quota limits, and the maximum noise level – as measured by the Quota Count – that aircraft operating in the night quota period are allowed to have.

These models were developed using the best available data sources given the resource and time constraints of the study, and seek to synthesize the complex range of possible responses by airlines and passengers to potential changes to the night flights regime. However, this is a highly complex topic requiring, by necessity, a series of simplifying assumptions, and these models have a number of other limitations, meaning that the results generated by these models are subject to significant uncertainty.

Whilst illustrative results are provided for a range of scenarios in the final report for this study, these scenarios were purely used to test that the models are producing plausible outcomes and to demonstrate the capability of the models. In other words, the scenarios presented in this report do not represent scenarios that are being considered by the Government in its review of the night flights regime.

EXECUTIVE SUMMARY

Background

Aircraft noise at night is a particular concern for people who live near to, or under, the flight paths of major airports. For many years the Government has set night flight restrictions at "designated airports" – London Heathrow (LHR), Gatwick (LGW) and Stansted (STN). These restrictions are referred to as the "night flights regime" and currently comprised of:

- Limits at each airport on the number of night flights during the night quota period (NQP) (from 23:30 to 06:00);
- Restrictions on the noisiest aircraft types (over the NQP or the entire night period – from 23:00 to 07:00 – depending on noise level); and
- Noise quota limits which cap the total amount of noise energy which can be emitted during the NQP at each airport.

The current night flights regime at Heathrow, Gatwick and Stansted airports will end in October 2017, and the Department for Transport (DfT) commissioned SYSTRA to undertake this research study on the "Economic Impacts of night flights" in November 2015 with the purpose of improving the Government's evidence base on this issue and therefore to inform its assessment of the impacts of the night flights regime that should apply from October 2017 onwards. SYSTRA were supported by Northpoint Aviation who provided specialist aviation inputs to the study.

This study seeks to break new ground in quantifying the economic impacts of possible changes to the night flights regime at the designated airports. Its key outputs are flexible models for each airport which can be used by the Department to estimate the economic impacts on airports, airlines, passengers and the public accounts from a range of potential changes to the current night flight regime. However, this study does not seek to assess the impacts associated with changes in noise pollution from aircraft. Whilst this impact is not considered here, it does form an important part of the Department's considerations in decisions on changes to the night flights regime.

For the purposes of this study, the economic impacts of possible changes to the night flights regime that are considered to be within scope represent first-order changes in the impacts of the night flights regime as experienced by:

- Airports;
- Passenger airlines;
- Cargo airlines;
- Passengers; and
- Public accounts.

Throughout this report, we refer to these groups collectively as 'economic actors'.

Industry Stakeholder Consultation

To inform the development of these models, a stakeholder consultation exercise was organised to engage with the industry (including relevant airports and airlines). Much of the information discussed with industry stakeholders is commercially sensitive in nature and therefore it is only possible to provide high level summaries within this report. Key highlighted views are as follows:

- There is demand for more night flights at all airports, with an expectation that additional allowances could be filled immediately.
- The costs to airlines of operating more night flights, and the costs to airports of providing supporting services, is considered negligible compared with the increased revenue that would be generated for both airports and airlines.

- An increased number of movements would be very beneficial at all airports and for all airlines to help with resilience issues by providing more flexibility for delayed flights to return, thereby reducing knock-on delays.
- Decreases in movements may result in schedule changes that result in whole rotations being lost, and therefore the range of destinations and the frequency with which they are served would be adversely affected, particularly where low cost and charter airlines are the dominant carriers.
- Alternative operational arrangements are less preferable or unsustainable for some airlines and cargo operators.
- Decreases in noise quotas during the night period would be likely to have similar effects as decreases in night movements if the quotas are reached.
- There is widespread support from airports and airlines for annual movement and noise quotas, rather than seasonal movement and quotas.

Modelling Approach

Key elements of the models functionality from a user's perspective are as follows:

- Heathrow, Gatwick and Stansted are modelled consistently, but separately;
- The models allow both an airport's movement and noise quota limits, and the maximum noise level – as measured by the Quota Count (QC) – that aircraft operating in the NQP are allowed to have, to be modelled;
- The models estimate the economic impacts over a 10 year period which begins in October 2017 and each year of this period is individually modelled;
- The summer and winter seasons are also modelled separately; and
- Users can vary both the input data used in the models and a range of other input parameters.

The models initially estimate an unconstrained scenario for each airport, which is intended to represent what would happen during this period in the absence of any night flight restrictions at the airport. The models then use this unconstrained scenario as the basis for estimating the economic impacts of the night flight restrictions that are specified for a given scenario. Two scenarios can then be compared to estimate the economic impacts of any changes in the night flight restrictions that are specified between the scenarios.

Given the resource and time constraints of the study and the complexity of the policy area, the models have a number of limitations, which mean that the results generated by the models are subject to significant uncertainty. The reader should keep this in mind when reviewing the report and its findings.

Some of the key limitations of the models are as follows:

- The models are a tool that can be used to inform and interpret within appropriate limits of variation. They do not generate definitive answers; the quality of the data and the assumptions used are material.
- The models were developed using the best available data sources given the resource and time constraints of the study. However, these constraints have, by necessity, required a range of simplifying assumptions to be made when dealing with a highly complex topic.
- Although every effort has been made to ensure that these assumptions are the best available within the resource and time constraints of the study, some assumptions have been made purely on the basis of SYSTRA and Northpoint's expert judgement.
- The results generated by the models are sensitive to these assumptions, the data sources that have been used and the methodological choices that have been made when developing the models; and are therefore subject to significant uncertainty.
- The models have been tested by modelling a range of scenarios to ensure that they are producing plausible outcomes. However, for the more aggressive of these scenarios, the responses may lie outside the range that can be inferred from the available model parameters and as such there will be more uncertainty surrounding the estimated outcomes for these scenarios. This is also the case

when modelling scenarios which involve changes greater than those that have been specifically tested as part of this project.

- The models estimate the economic impacts relating to both passenger flights by full service, low cost and charter airlines, and freight only flights. However, the models do not estimate the economic impacts in relation to any other flights, such as government flights and general aviation; these flights are collectively referred to as "non-commercial" flights elsewhere in this report for simplicity.
- Although "non-commercial" flights are taken into account in the models when determining whether the movement and noise quota limits have been met, the economic impacts relating to these flights could not be modelled because SYSTRA and Northpoint have no means of assessing the rationale for these flights and hence any changes in behaviour in a constrained scenario, and do not have access to any data on costs and revenues for these flights. This limitation has a more significant effect on the results for Stansted given that it has a much higher number of these flights compared to Heathrow and Gatwick.
- The models do not estimate the following economic impacts:
- Airline balance sheet values associated with slots gained or lost;
- Any costs to airlines or airports for 'purchase' of grandfather rights (associated with slots) or compensation due;
- Flight and aircraft scheduling or fleet optimisation changes;
- Operational flexibility impacts (e.g. related to crew scheduling); and
- Freight responses from service providers (e.g. impacts on shippers who can no longer guarantee delivery of goods by a certain time of day and the knock-on impacts to their customers).
- The approach used seeks to model the impacts of the night flights regime on flights operating in the NQP; and the corresponding direct impacts in the shoulder periods (23:00 to 23:30 and 06:00 to 07:00) (under scenarios where flights are assumed to be retimed to/from the NQP). However, it does not cover any further indirect impacts during the rest of the day (such as any further impacts on aircraft deployment).

Nevertheless, the authors of this report consider that this project provides a starting point for the analysis of the economic impacts on airports, airlines, passengers and the public accounts from possible changes in the night flights regime and a platform for possible further work in the future.

Model Results

Illustrative results are provided for a wide range of scenarios in this report. These scenarios have been purely used to test that the models are producing plausible outcomes and to demonstrate their capability. They do not represent scenarios that are being considered by the Government.

The results show the estimated impacts of the changes of the night flight regime under these scenarios, relative to a counterfactual where the current night flight regime remains unchanged during the modelling period. This counterfactual is referred to as the baseline scenario elsewhere in this report.

For each of these scenarios, a range of estimates is provided, illustrating the uncertainty around the impacts of the scenario. This uncertainty has been modelled by varying how airlines are assumed to respond to the changes to the night flight regime only, and consequently does not reflect the full range of uncertainty around these results.

1. STUDY OBJECTIVES AND SCOPE

1.1 Background and Study Objectives

Aircraft Noise and the Night Flights Regime

1.1.1 Aircraft noise at night is a particular concern for people who live near to, or under, the flight paths of major airports. For many years the Government has set night flight restrictions at "designated airports" – London Heathrow (LHR), Gatwick (LGW) and Stansted (STN). These restrictions are referred to as the "night flights regime". More specific details on the night flights regime can be found in Section 1.2 of this report.

Objective of this study

1.1.2 The current night flights regime at Heathrow, Gatwick and Stansted airports will end in October 2017, and the Department for Transport (DfT) commissioned SYSTRA to undertake this research study on the "Economic Impacts of night flights" in November 2015 with the purpose of improving the Government's evidence base on this issue and therefore to inform its assessment of the impacts of the night flights regime that should apply from October 2017 onwards. SYSTRA were supported by Northpoint Aviation who provided specialist aviation inputs to the study. Specifically, Northpoint Aviation played a key role in the stakeholder engagement, sourced suitable data for input to the models, undertook initial processing of this data, and contributed to the study reports and the quality assurance of the models.

1.1.3 This study seeks to break new ground in quantifying the economic impacts of possible changes to the night flights regime at the designated airports. Its key outputs are flexible models for each airport which can be used by the Department to estimate the economic impacts on airports, airlines, passengers and the public accounts from a range of potential changes to the current night flight regime. However, this study does not seek to assess the impacts associated with changes in noise pollution from aircraft. Whilst this impact is not considered here, it does form an important part of the Department's considerations in decisions on changes to the night flights regime.

1.1.4 This study was commissioned and undertaken within a specific set of resource and time constraints. These constraints have, by necessity, required a series of simplifying assumptions to be made when dealing with a highly complex topic. Where appropriate, these have been explicitly stated. In addition, the models developed as part of this study have a number of other limitations. Therefore, the results generated are subject to significant uncertainty. The reader should keep this in mind when reviewing the report and its findings.

Study Approach

1.1.5 The study was divided into two stages as follows:

- Stage 1 – Determination of methodology, establishing data availability and undertaking stakeholder engagement
- Stage 2 – Development of models and estimation of the impacts for a range of test scenarios

1.1.6 The models ultimately developed were the result of a number of key factors, including:

- Data availability
- Information gleaned from the stakeholder interviews

- Review of the available literature describing the potential impacts of changes to the night flight regimes
- Series of iterative discussions with the DfT as to their practical needs and requirements in terms of assessing impacts of potential changes to the current night flights regime.

1.2 Study Parameters and Terminology

Policy Context

1.2.1 The Government's approach to night flights at the designated airports is set out in the Aviation Policy Framework (APF), published in March 2013[1], which sets out the Government's overall objectives for aviation. Given the strategic importance of these airports to the UK economy, the Government sets night flight restrictions to balance the economic benefits of night flights at these airports with the noise impacts they have on communities.

1.2.2 There are various restrictions on night flights at Heathrow, Gatwick and Stansted airports, for the entire night period (23:00 to 07:00) or part of this period. In summary, these are:

- Limits on the overall number of night flights during the night quota period (NQP) ie. 23:30 – 06:00
- Restrictions on the noisiest aircraft types (over the night quota period or the entire night period – from 23:00 to 07:00 – depending on noise level); and
- Noise quota limits which cap the total amount of noise which can be emitted during the NQP.

1.2.3 Numerical movement limits are set for every summer and winter season at each of the three airports. Under the existing regime, airports are given the flexibility to defer or bring forward movement and quota allowances from one season to the next. Specifically, airports can carry over up to 10% of their movement quota and their noise quota into the next season if it is unused. Conversely, if an airport overruns their movement or noise quota by up to 10%, this amount will be deducted from their quota for the next season. If an airport overruns their movement or noise quota by more than 10%, their movement or noise quota for the next season will be reduced by the amount of the excess up to 10% plus twice the amount of the excess over 10%. The movement and quota limits cannot be exceeded by more than 20% in any given season[2].

1.2.4 Noise quotas take account of the noise emitted by individual aircraft movements against an overall quota or noise budget. This is done separately for landing and take-off movements using the Quota Count (QC) classification system. Each aircraft is assigned a "QC Rating" depending on the amount of noise generated. There are current QC categories that are based on International Civil Aviation Organisation (ICAO) noise certification. Flights by aircraft with a QC rating of zero are currently exempt from the movement and noise quota limits, and can therefore currently operate unrestricted in the NQP.

1.2.5 There are also dispensations for certain types of movements that do not count towards the movement or noise quota limits, for example humanitarian or VIP flights, or in the event of emergencies, widespread and prolonged air traffic disruption.

1.2.6 The following specific time periods will be under consideration in this study:

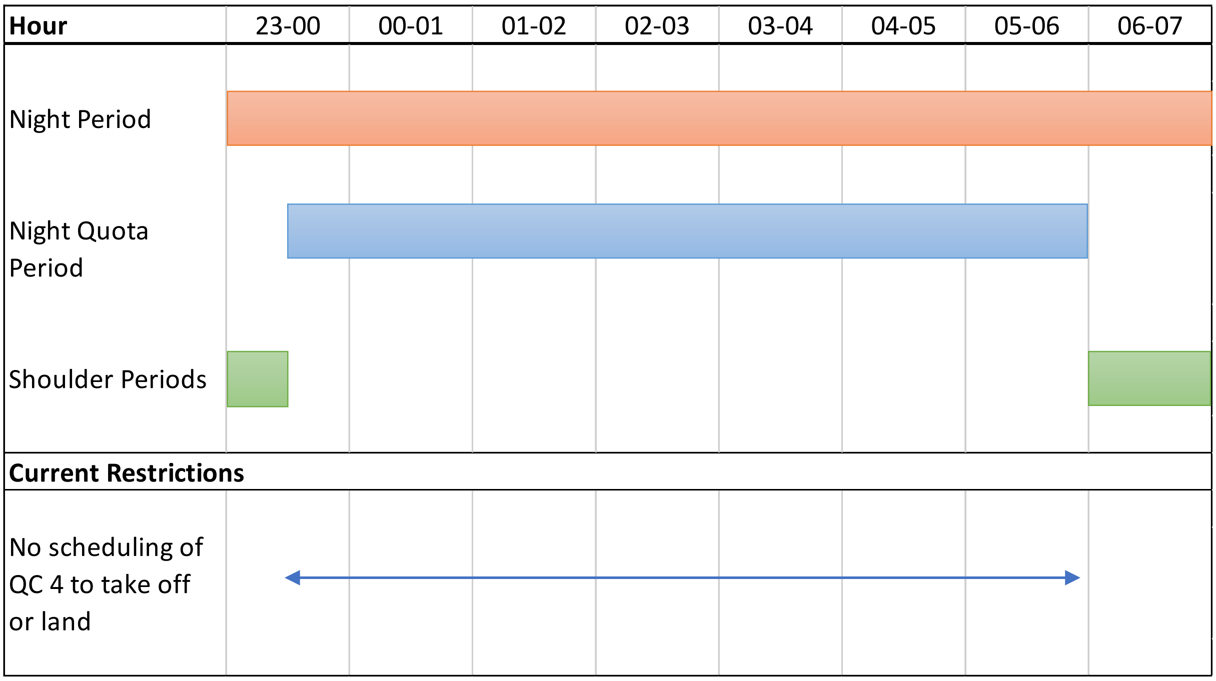
- Entire night period; 23:00 to 07:00
- Night quota period (NQP); 23:30 – 06:00

[1] https://www.gov.uk/government/publications/aviation-policy-framework
[2] Night Flying Restrictions at Heathrow, Gatwick and Stansted Airports: Impact Assessment – Department for Transport, July 2014

- Shoulder Periods; 23:00 to 23:30 and 06:00 to 07:00

1.2.7 **Figure 1** provides a graphical representation of the current night flights restrictions, whilst also introducing nomenclature for generic time periods used throughout the study.

Figure 1: Night Flights Time Periods and Take-off / Landing Restrictions



Impacts in Scope

1.2.8 For the purposes of this study, the economic impacts that are considered to be within scope represent first-order changes in the impacts of the night flights regime as experienced by:

- Airports
- Passenger airlines
- Cargo airlines
- Passengers
- Public accounts

1.2.9 Any behavioural change during the night period that each, or all, of these five groups might exhibit as a result, is included within the scope of this commission, as are the knock-on effects between the five groups (e.g. how the impacts on these groups would change as a result of how airlines respond to a change in the night flights regime is included within this scope). Even if the effects are small relative to total impacts, the study has sought to quantify and monetise them as far as practicable. However, other knock-on effects are not covered, nor are GDP and employment impacts.

1.3 Contents of this Report

1.3.1 This report has been produced at the end of Stage 2 of the study and builds upon the earlier Stage 1 Report submitted in April 2016. This Final Report covers the following key elements:

- Study objectives and scope
- Stakeholder consultation
- Model development
- The modelling approach
- Illustrative model results and findings
- Conclusions

1.4 Literature Review Summary

1.4.1 A review of the available literature is presented in **Appendix A**.

1.4.2 In summary, there is a consensus amongst the various studies that night flights across Europe add considerable value to their respective economies. Most of the studies which explore the value of night flights, do so in terms of a broad economic perspective focusing on employment and Gross Value Added. The consensus in the literature breaks down when it comes to quantifying the economic value of night flights and the corresponding costs of reducing or eliminating them entirely. This demonstrates the complexity in estimating such impacts and is one of the key reasons why this study has adopted a more narrow definition of impacts.

1.4.3 That said, certain aspects of previous studies have been retained for this study. For example the range of possible commercial responses by airlines and airports have referenced those set out in the 2011 Oxford Economics Study of the Economic Value of Night Flights at Heathrow. Since this study adopts a narrower definition of impacts, excluding more nebulous wider economic benefits, it is expected that the findings will be less contentious. Nevertheless, the task remains a complex one; where simplifying assumptions have, of necessity, had to be used as discussed above.

2. STAKEHOLDER CONSULTATION

2.1 Overview of Stakeholder Consultation Exercise

2.1.1 To inform the development of the models, a stakeholder consultation exercise was organised to engage with the industry. The goals of the engagement exercise were:

- To provide an opportunity to hear, first-hand, how different players within the sector might respond to possible regulatory changes, and to explore and challenge the underlying rationale for each organisation's stated approach;
- To collect relevant data on impacts of such changes, where possible; and
- To allow affected parties to, in part, shape the parameters of the study, thereby avoiding later criticism that the study is too theoretical and insufficiently based on empirical evidence of likely behavioural responses.

2.2 Stakeholder Interviews Undertaken

2.2.1 Stakeholder interviews were undertaken with the following organisations during the period 8th to 11th December 2015:

- Heathrow, Gatwick and Stansted Airports;
- Airport coordination Limited (ACL), Civil Aviation Authority (CAA) and NATS;
- 2 cargo airlines; and
- 4 passenger airlines.

2.2.2 In some cases it was not possible to schedule a face-to-face interview and the consultation was conducted in the form of written questions and answers by the stakeholder. The nature and level of engagement by interviewees was positive and helpful.

2.2.3 Much of the information discussed with stakeholders is commercially sensitive in nature. This information has been used to shape and formulate the progress of the study. The commercially sensitive nature of these discussions mean that it is only possible to publish such content with the permission of the respective stakeholders.

2.2.4 Where such permission has been given, high-level summaries of individual stakeholder interviews have been included in **Appendix B**.

2.3 Key Findings from Stakeholder Interviews

2.3.1 This section provides a high level summary of some of the key findings of the stakeholder interviews.

2.3.2 Responses to increases in movements during the night period were as follows:

- There is demand for more night flights at all airports, with an expectation that they could be filled immediately. It is generally considered that there is demand from airlines and passengers for an increase in movements, and that such an increase would help the airports to grow; provide more competition between airlines, and thus bring down prices for customers. It would also provide more choice of destinations and times for passengers. An increase in the number of passenger night flights and destinations may also provide an increase in bellyhold capacity and therefore the range of destinations for time sensitive cargo and hence would contribute to the future growth of the air cargo industry.
- The costs to airlines of operating more night flights, and the costs to airports of providing supporting services, is considered negligible compared with the increased revenue that would be generated for both airports and airlines.

- An increased number of movements would be very beneficial at all airports and for all airlines to help with resilience issues that are a major cause of delays. It is understood that a significant proportion of an additional quota would be likely to be allocated to the pool to cover for over-running schedules, rather than be allocated to the schedule itself.

2.3.3 Responses to decreases in movements during the night period were as follows:

- In some cases whole rotations would be lost, and therefore the range of destinations and the frequency with which they are served would be adversely affected, particularly where low cost and charter airlines are the dominant carriers.
- Alternative operational arrangements are less preferable or unsustainable for some airlines and cargo operators. Alternatives include moving operations to different airports, but this often creates other difficulties: alternative airports may not be able to support sufficient passenger demand, may be too far from London to ensure cargo services are reliable, and may not have adequate runway length or the desired operating conditions for the aircraft concerned.

2.3.4 Decreases in noise quotas during the night period would be likely to have similar effects as decreases in night movements if the quotas are reached, particularly on the airlines and cargo operators which use the noisier aircraft.

2.3.5 There is widespread support for annual movement and noise quotas, rather than seasonal movement and quotas.

3. MODEL DEVELOPMENT

3.1 Model Implementation

3.1.1 The models were developed iteratively to achieve the required flexibility and functionality while also trying to keep file size and run times to a reasonable level given the complexity and dimensions of the approach needed to meet DfT requirements. The volume of data involved and the amount of processing required result in file sizes for each model of around 80 to 95 MB.

3.1.2 Key elements of the models functionality from a user's perspective are as follows:

- Heathrow, Gatwick and Stansted are modelled consistently, but separately;
- The models allow both an airport's movement and noise quota limits, and the maximum noise level – as measured by the QC – that aircraft operating in the NQP are allowed to have, to be modelled;
- The models estimate the economic impacts over a 10 year period which begins in October 2017 and each year of this period is individually modelled;
- The summer and winter seasons are also modelled separately; and
- Users can vary both the input data used in the models and a range of other input parameters.

3.1.3 A range of potential night flights regime policy scenarios have been tested to assess the robustness of the models. These cover a range of potential increases or reductions to the movement quota and the noise quota, alongside some potential options to change the scope or application of the night noise regime. **Appendix C** shows the potential policy scenarios for which estimates are presented in this report. There is no suggestion that such policy scenarios are under consideration by the DfT, they have only been devised to validate the operational integrity of the models and to allow for checking the plausibility of the outputs.

3.1.4 A simplified model user guide has been produced to provide a summary of how the model should be used.

3.1.5 The model has been designed to be compatible with Microsoft Excel 2013. Furthermore, it has been designed to be usable by DfT staff with basic Microsoft Excel knowledge and follow the principles laid out in the FAST Standard[3].

3.1.6 SYSTRA have developed to the models with reference to the Department for Transport's Analytical Assurance guidance[4] and guidance on Quality Assurance of Analytical Modelling[5]. In addition, SYSTRA consider that the approach taken is consistent with the HM Treasury Green Book[6], DfT's WebTAG guidance[7] and the Better Regulation Framework Manual[8].

3.1.7 Copies of the models for each airport have been provided to DfT. In addition, the other analysis that has been undertaken as part of this project (such as the analysis used to aggregate the raw data input into the flight groupings used in the models), the raw input data used when developing the models and any supporting documentation have been provided to the DfT where possible. There are some limitations to this given the high degree of commercial sensitivity of some of the raw data (in particular that relating to airline costs and

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[3] http://www.fast-standard.org/wp-content/uploads/2015/03/FASTStandard_02a.pdf
[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/353372/strength-in-numbers.pdf
[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/350904/qa-modelling-guidance_pdf.pdf
[6] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent
[7] https://www.gov.uk/guidance/transport-analysis-guidance-webtag
[8] https://www.gov.uk/government/publications/better-regulation-framework-manual

revenues). In such cases, raw data has only been provided at an aggregate level and consequently not all of the analysis used to aggregate the raw data has been provided to the DfT.

3.2 Model Limitations

3.2.1 Given the resource and time constraints of the study and the complexity of the policy area, the models have a number of limitations, which mean that the results generated by the models are subject to significant uncertainty. The reader should keep this in mind when reviewing the report and its findings. Some of the key limitations of the models are as follows:

- The models are a tool that can be used to inform and interpret within appropriate limits of variation. They do not generate definitive answers; the quality of the data and the assumptions used are material.
- The models were developed using the best available data sources given the resource and time constraints of the study. However, these constraints have, by necessity, required a range of simplifying assumptions to be made when dealing with a highly complex topic.
- Although every effort has been made to ensure that these assumptions are the best available within the resource and time constraints of the study, some assumptions have been made purely on the basis of SYSTRA and Northpoint's expert judgement.
- The results generated by the models are sensitive to these assumptions, the data sources that have been used and the methodological choices that have been made when developing the models; and are therefore subject to significant uncertainty.
- The models have been tested by modelling a range of scenarios to ensure that they are producing plausible outcomes. However, for the more aggressive of these scenarios, the responses may lie outside the range that can be inferred from the available model parameters and as such there will be more uncertainty surrounding the estimated outcomes for these scenarios. This is also the case when modelling scenarios which involve changes greater than those that have been specifically tested as part of this project.
- The models estimate the economic impacts relating to both passenger flights by full service, low cost and charter airlines, and freight only flights. However, the models do not estimate the economic impacts in relation to any other flights, such as government flights and general aviation; these flights are collectively referred to as "non-commercial" flights elsewhere in this report for simplicity.
- Although "non-commercial" flights are taken into account in the models when determining whether the movement and noise quota limits have been met, the economic impacts relating to these flights could not be modelled because SYSTRA and Northpoint have no means of assessing the rationale for these flights and hence any changes in behaviour in a constrained scenario, and do not have access to any data on costs and revenues for these flights. This limitation has a more significant effect on the results for Stansted given that it has a much higher number of these flights compared to Heathrow and Gatwick.[9]
- The models do not estimate the following economic impacts:
- Airline balance sheet values associated with slots gained or lost;
- Any costs to airlines or airports for 'purchase' of grandfather rights (associated with slots) or compensation due;
- Flight and aircraft scheduling or fleet optimisation changes;
- Operational flexibility impacts (e.g. related to crew scheduling); and
- Freight responses from service providers (e.g. impacts on shippers who can no longer guarantee delivery of goods by a certain time of day and the knock-on impacts to their customers).

[9] In 2014/15, it is estimated that "non-commercial flights" represented less than 1% of the night flights in the NQP at Gatwick and Heathrow and approximately 7% of these flights at Stansted.

- The approach used seeks to model the impacts of the night flights regime on flights operating in the night quota period (NQP); and the corresponding direct impacts in the shoulder periods (23:00 to 23:30 and 06:00 to 07:00) (under scenarios where flights are assumed to be retimed to/from the NQP). However, it does not cover any further indirect impacts during the rest of the day (such as any further impacts on aircraft deployment).

3.2.2 Other limitations are described elsewhere in the report where relevant.

3.3 Model Usability

3.3.1 The models have been designed to be used flexibly to analyse a wide range of night flight regime policy issues. File size issues mean that Heathrow, Gatwick and Stansted are covered by separate models, yet these all share the same approach and underlying spreadsheet, they only differ in terms of the data inputs.

3.3.2 Within each year of the modelling period, the default model setting is that the summer and winter seasons are modelled separately (e.g. different movement limits and/or noise quotas for each season), and the models allow the key features of the night flights regime to be varied in each season in the modelling period (such as the level of carryovers and overruns). The User also has the flexibility to input externally computed values for the aircraft movements and noise quotas allowed in each season under the night flights regime.

3.3.3 The models also provide the option of modelling policy scenarios on an annual basis (i.e. annual movement limits and noise quotas). Where movement limits and noise quotas are annualised, it has been assumed that each winter season would be combined with the subsequent summer season (i.e. in any given year, the annual movement limits and noise quotas would apply from the start of the winter season in October to the end of the summer season in the following October).

3.3.4 The models do not currently include any data on flights during the NQP that are granted dispensations as these flights are not currently covered by the night flights regime (see paragraph 1.2.5 for more details). Therefore, the models do not include the functionality to analyse the economic impacts of changes to the treatment of these flights.

3.3.5 The models produce estimates of:

- the total value of each economic impact at each airport in each year of the modelling period in real terms for airlines, airports, passengers and government (Public Accounts); and
- the total value of each economic impact at each airport over the entire modelling period in real terms expressed in present value terms[10].

3.3.6 The models have a Price Base Year of 2015. Where estimates are presented in present value terms, the models have a default Present Value Base Year of 2016/17, although users can vary this by changing a user input.

3.3.7 In the models, each year begins at the start of a winter season in October and comprises the winter season and the following summer season (e.g. 2014/15 comprises the 2014/15 winter season and the 2015 summer season).

Modelling Test Scenarios

3.3.8 The impacts of the test scenarios in **Appendix C** have been assessed relative to a counterfactual (Baseline) that the current Government policy on night flights remains

[10] Discounted according to Green Book guidance

unchanged during the modelling period (i.e. the current movement limits and noise quotas remain unchanged for the period October 2017 to October 2027).

3.3.9 For each of the test scenarios in **Appendix C**, a range of estimates of the impacts of the test scenario is provided in **Appendix F**, illustrating the uncertainty around the impacts of the test scenario. This uncertainty has been modelled by varying how airlines are assumed to respond to the changes to the night flight regimes only, and consequently does not reflect the full range of uncertainty around these results.

3.4 Commercial, Passenger and Cargo User Responses Included in the Model

3.4.1 A "Commercial Response" is defined as a series of actions undertaken by airports or airlines in response to a specific policy scenario.

3.4.2 Each of the policy scenarios outlined in Appendix C would be expected to generate commercial responses by airlines and airports. The categories of commercial response have been defined following consultation with the airline and airport stakeholders and are tabulated below. The model allows the following commercial responses to be modelled. The comparisons in the following Table 3.1 are made relative to the Unconstrained Scenario (i.e. a scenario which is intended to represent what would happen in the absence of any night flight restrictions at the airport).

Table 3.1: Commercial Responses relative to the Unconstrained Scenario

COMMERCIAL RESPONSE
Retiming of flight(s) from the night quota period to the shoulder periods
Retiming of flight(s) from the night quota period to the shoulder periods requiring the displacement of other flight(s) during the shoulder periods
Switching to using quieter aircraft(s) in the night quota period
Relocation of flight(s) to other UK airport(s)
Relocation of flight(s) to non-UK airport(s)
No alternative to removing flight(s) from the night quota period

3.4.3 The impact of each 'choice path' of each commercial response was assigned a monetary value from the perspective of airlines and airports. The cost and revenue changes for each 'choice path' have been recorded to provide a comparison with those in the Unconstrained Scenario to show the relative change. Examples of cost and revenue changes could include:

- Retiming a flight may result in lost revenue for both the airline and airport from those passengers who choose to no longer fly due to the inconvenience.
- Relocating a flight to another airport would also result in lost revenue from those passengers who choose to no longer fly due to the inconvenience.
- Total cancellation of a flight would result in a loss of all of the revenue but a saving on the cost of operating the flight.

3.4.4 The passenger response would be expected to vary by the sector in question. However, for analytical purposes, passenger responses can be grouped into three categories as summarized below.

Table 3.2: Passenger Responses

LABEL	PASSENGER RESPONSE
A	Re-schedule the journey to match new flight time
B	Travel on alternative flight / airline or via other airport
C	No longer travel

3.4.5 Considerations in setting the rules for determining passenger responses include:

- **Business / Leisure Passenger Split** - Business passengers will be the most constrained since they will generally need to be in a certain place at a certain time. They have a higher value of time since their travel will usually be paid for by their employer. In analytical terms, this means that they will be less sensitive to changes in air fares, for example. The business / leisure split is therefore incorporated into the analysis.

- **Origin-Destination / Transfer Passenger Split** – Origin-Destination (OD) passengers, ie those on a point-to-point flight, are highly resistant to routeing a particular flight via an alternative airport since it will result in a longer journey time and a loss of productive working or holiday time. Transfer passengers will be much less loyal to a specific hub; the choice of transfer airport is less important than the overall journey time and convenience. The OD / Transfer split is therefore incorporated into the analysis.

3.4.6 Passenger responses have been determined as a result of the potential commercial response. For example, in the case of a retimed flight, the business / leisure split influences the proportions of passengers likely to be willing to re-time their journey.

Cargo Transport Responses

3.4.7 Based on our understanding of airport operations at the three airports and the findings of the stakeholder consultation, it is considered that the impacts of such changes on the air cargo industry in wider economic terms may be significant, but that is beyond the scope of this study. The stakeholder consultation revealed a number of examples of how this might occur. If a cargo operator could no longer bring their shipment into one of the three London airports in the very early morning it is likely they would use belly holds of aircraft going into an EU hub and transferring to road to get into the UK. The cost differential for the cargo operator would be minimal; however, the shipper would experience a delay of around 24 hours. This 24 hour delay would have significant implications for the "just-in-time" type businesses which ship tools and commodities by air.

3.4.8 The remainder of this section discusses each of the following groups in turn.

- Integrators operating their own or chartered aircraft;
- Integrators and Freight Forwarders buying space in belly of passenger aircraft; and
- Airlines operating full main deck freighter aircraft.

Integrators operating their own or chartered aircraft

3.4.9 Integrators rely heavily on night movements of the aircraft they control when it comes to serving the London and SE markets. Airports located further north such as East Midlands cannot provide the time-definite connectivity required to distribute freight by road, especially for pre 9.30am express deliveries across London.

3.4.10 Both Stansted and Heathrow are used by the integrators[11] for their own flight operations. On certain movements, Luton is used as a Heathrow alternate due to the night restrictions with the cargo moving between the two airports by road.

3.4.11 Reducing night flights would impact the businesses of the integrators insofar as they would need to serve London and the south-east of England either by operating into an EU hub and trucking or using a different UK airport; either solution could involve a delay to the cargo flow depending on distance to destination. The main loser here is the shipper/customer and ultimately the UK economy, as the integrator would add any additional costs to the price of the service provided. The impact on the airport would be the lost revenue from the movement.

3.4.12 Opening up to more night flights on the other hand would probably not make much difference to the market in its present state[12], but the existing regime is likely to stifle growth in the future e.g. a growth market with internet sales continuing to grow. The airport would benefit from the associated revenue from the movement assuming it is additional rather than displaced.

3.4.13 The expected outcome for charter cargo is that the demand would be impacted by any constraints in capacity at a particular airport and volumes would be affected.

Integrators and Freight Forwarders (IFF) buying space in belly of passenger aircraft

3.4.14 This is really only applicable at Heathrow as there is little belly freight at either of Gatwick or Stansted, because this does not form part of the business models of the low cost carriers that dominate both airports (i.e. EasyJet and Ryanair respectively) because of its potential impact on turn round times.

3.4.15 The early inbound flights particularly from the Far East are well used by the IFF businesses. The early arrival of these flights currently allow the inbound cargo to get transferred to the road network in time to be delivered to most parts of the UK the same day.

3.4.16 A reduction in night flying (specifically the early morning arrivals) could be damaging to the cargo flow network. The direct impact on the IFF which is being modelled is not significant but the impact to the customer/shipper is likely to be. The displaced cargo may then be flown into an EU hub or to a later flight, undermining the potential for same day delivery. The cargo could be delayed by up to a day reducing the value to the UK economy and impacting the competitiveness of some UK businesses, especially where they are serving the same markets as firms based on the continent readily accessible from less restricted hubs and freight airports.

3.4.17 Conversely, more night flights into Heathrow would allow the supply of early morning belly-hold capacity from certain destinations to be released onto the market and feedback indicates that there is a strong demand for such additional capacity. Again, the impact on the revenues of IFF's would be marginal overall, compared to the wider economic benefit likely to be derived from making London more competitive for early morning package and parcel deliveries, although even this should not be overstated. That said, the airport would clearly benefit from more flights (assuming the capacity was available) from the direct revenues derived.

[11] Most of the movements at Heathrow are not scheduled.

[12] At present, there is not a lot of growth in the time critical express freight market and there is a plenty of capacity for the marginal levels of growth predicted over the next 3 to 5 years in the dedicated freighter and bellyhold components of the market.

3.4.18 More generally, less time critical cargo carried on passenger aircraft is primarily likely to be impacted by any constraints in capacity at a particular airport and the resultant effect on belly-hold volumes available to shippers and forwarders.

Cargo user responses for full main deck freighter aircraft

3.4.19 Full main deck freighter aircraft are operated by airlines (who usually operate passenger services separately as well) selling space to forwarders; however presently, these do not seem to operate regularly at night and so would only be impacted if displaced by a flight moving from night-time to daytime (which is unlikely). For completeness however, the impacts of gaining or losing these flights are essentially the same as described above as far as the airport and the wider economy is concerned. Clearly the impact on the airline could be greater if the flight can't be viably operated elsewhere in the event it loses its slot and conversely, an increase would accrue additional revenues to the airline assuming there is sufficient market demand.

3.4.20 The expected outcome for full freighter cargo is that demand would be impacted by any constraints in capacity at a particular airport and volumes would be affected.

3.5 Model Dimensions

3.5.1 It is not meaningful or feasible to analyse the schedule in terms of individual commercial aircraft movements. As part of the model development process there has therefore been an aggregation of the raw aircraft movement data to a series of flight groupings which distinguish between the key operational or cost characteristics, or dimensions, of the flights. These dimensions are reflected in the model to distinguish between different groups of:

- **Length of hau**l (Route Length): segmented into three hour bands reflecting break points for crew operation and scheduling: < 3 hours, 3 - 6 hours, 6 - 9 hours, 9 – 12 hours, 12+ hours
- **Type of Operation** (Carrier type): Scheduled full service, low-cost carrier, charter operation, freight
- **Aircraft Type**: groupings of size type (0-70, 71-150, 151-250, 251-350, 351-500, 501+ seats) and QC rating[13]
- **Direction**: arrival and departure separately identified
- **Season**: Summer and Winter separately identified and modelled
- **Daily Time Period** (Time Band): Bands based on time of operation in the night period (either an hour or 30 minutes)

3.5.2 The basic unit of analysis adopted in the models is the flight grouping and flights were grouped together into flight groupings on the basis of the above dimensions. In the models, analysis is undertaken on the basis of average metrics per flight (costs, revenues, margins, etc.) across these flight groupings.

3.6 Modelling the Flight Schedule

3.6.1 For each airport, the raw input data has been aggregated offline into the above flight groupings and input to the excel models in this aggregated form. This raw input data is an exogenous input to the excel models.

3.6.2 The models can be used to estimate the flight schedule in the NQP for these flight groupings for a ten year modelling period starting from the winter 2017/18 period for the following internally consistent situations:

13 Flights performed by aircraft with a different quota count (QC) would be assigned into different flight groupings; and flights performed by aircraft with the same quota count (QC) would be assigned into different flight groupings if the passenger capacity of the aircrafts puts them in a different size type.

- **Unconstrained**: A scenario where there are no night flight restrictions during the modelling period.
- **Baseline:** A scenario where the current night flight regime remains unchanged during the modelling period. This scenario is used as the baseline for assessing the impacts of the test scenarios.
- **Test scenarios**: Any given alternative night noise regime scenarios.

3.6.3 For the Baseline and each test scenario, the number of movements in the NQP in each flight grouping at each airport in each year of the modelling period (split between the summer and winter seasons) are automatically estimated by the models. In each case, the outcomes from these scenarios are based on the number of movements estimated for the unconstrained scenario, but will be limited by any constraints that are imposed by the limits in place under the policy scenario (e.g. the movement limit, noise quota and maximum QC of aircraft).

3.6.4 The models produce the estimates for flights in the NQP under the Unconstrained scenario based on assumptions that have been made about the future fleet mix used for night flights in the NQP at each airport and the growth in the number of night flights in the NQP at each airport. These assumptions were provided to SYSTRA by the DfT, and match those used in the DfT's consultation-stage impact assessment on the next night flights regime [14]. These assumptions are subject to uncertainty and will impact on the results estimated by the models.

3.6.5 In contrast, for existing flights in the shoulder periods, it is assumed that there are no changes to the fleet mix and no growth in the number of these flights over time as simplifying assumptions. Again, these assumptions are subject to uncertainty and will impact on the results estimated by the models.

3.7 Data Sources and Inputs

3.7.1 For each airport, input data for flights during the NQP and shoulder periods in the 2014/15 base year was assembled and formatted offline from the main excel models, distinguishing between seasons; i.e. separately identifying summer and winter. The key input data sources are shown below in Table 3.3. The input data was aggregated to the flight groupings as described in Section 3.5.

3.7.2 A significant portion of the cost and revenue data was obtained from RDC Aviation, a highly regarded specialist UK consultancy whose core on-line business involves the harvesting, interrogation, formatting and supply of airport and airline cost and revenue data and supporting proprietary analytical tools. Their customers include many of the large airports and airlines as well as some smaller ones and their track record is well established and respected within the industry.

3.7.3 In a small number of instances SYSTRA manually edited some of the data for the shoulder periods. This was done where the values in the raw data did not look plausible. In such circumstances SYSTRA imputed values based on information from the night quota period.

14. " https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/582867/night-flights-impact-assessment.pdf, see sections 7.1.4 and 7.1.5 for further details.

Table 3.3: Summary of Data Sources Used for Cost and Revenue Inputs

Legend

CAA	Civil Aviation Authority (CAA) Data on the actual night flights in 2014/15
DfT	DfT analysis to estimate average load factors from CAA data for 2011-2014 by route and carrier type
RAD	RDC Aviation database
Northpoint	Northpoint Aviation
PA	Published Airport Accounts
COU	Airport Published Charges
GOV	www.gov.uk

Data Sources

Flight Movements, Airline Costs & Revenues	Source
Airline	CAA
Operation Type (Arriving or Departing Flight)	CAA
Core Night Period / Shoulder Period	CAA
Origin / Destination Airport	CAA
Time of flight	CAA
Aircraft	CAA
Capacity (seats) (night quota period only)	CAA
Capacity (seats) (shoulder periods only)	RAD
Quota Count (QC) (night quota period only)	CAA
Quota Count (QC) (shoulder periods only)	Northpoint
Maximum take-off weight (MTOW) of the aircraft (tonnes)	Northpoint
NOx emissions per landing / take-off (LTO) cycle (tonnes)	Northpoint
Noise certification categories of the aircraft	Northpoint
Airport Pair Distance ('distance') [km]	Northpoint
Average Aircraft Speed ('cruise speed') [km/hr]	Representative values derived by SYSTRA from published sources

Fixed Costs (Capital / Lease Cost of Aircraft)[15]	RAD
Variable Costs – Fuel (noting rates paid and £/$ rate)	RAD
Variable Costs – Airport Charges	RAD
Variable Costs – Others[16]	RAD
Indirect Costs (Airline Overheads)[17]	RAD
Average Yield (i.e. fare income per pax excluding APD and other taxes)	RAD
Ancillary revenue per pax (i.e. baggage charges, in-flight sales margins excluding taxes)	RAD
Passenger Load Factors (night quota period only)	DfT
Passenger Aircraft Seating Configuration (night quota period only)	CAA
Cargo revenue per sector	RAD
Airport Costs & Revenues	**Source**
Airport Unit Operating Costs	PA
Airport Charges to Airline per take-off / landing	COU
Airport Charges to Airline per departing passenger	COU
Airport Commercial Revenues per passenger	PA
Public Accounts Costs	**Source**
Air Passenger Duty (by calculation from departing passengers)	GOV
VAT on retail purchases (by calculation based on airport commercial revenues per passenger)	PA

Flight Movements, Airline Costs & Revenues

3.7.4 CAA data for 2014/15 was provided by the DfT, comprising of records for the aircraft operations in both the Night Quota Period (NQP) and the shoulder periods by:

- Season[18]
- Airport
- arrival/departure
- destination or origin

[15] Capital Costs, Fixed element of Maintenance

[16] Variable element of Maintenance, Crew cost, Passenger Service

[17] Costs not directly associated with flying: marketing, ticketing, management etc

[18] A very small number of flights were reassigned between seasons when processing this data into the model dimensions to ensure data consistency.

- time of arrival/departure
- flight identifier
- aircraft type
- number of seats and the seating configuration (night quota period only)
- quota count (QC) of aircraft (night quota period only)

3.7.5 The aircraft operations data were processed into the modelled dimensions by:

- Appending separate load factor data for flights in the night quota period; and assumed load factors for flights in the shoulder periods[19]
- Adding in separate data on seats and QC for flights in the shoulder periods.
- Applying an algorithm to determine the size type of the aircraft based on the number of seats for passenger flights; and assumptions about the seating capacity of each aircraft for freight only flights[20].
- Assigning flights a carrier type (Scheduled full service, low-cost carrier, charter operation, freight). This was based on the assumptions DfT made for its fleet mix modelling for flights in the NQP (although a very small number of changes were made to these based on SYSTRA's judgement); and SYSTRA's assumptions for flights in the shoulder period[21].
- Calculating passenger numbers by seat class (e.g. first class, business class, etc) based on splitting the total number of seats according to the CAA aircraft configuration data provided by the DfT for flights in the night quota period, and the simplifying assumption that all seats are economy class for flights in the shoulder periods; and the load factors described above.
- Adding in separate data on distance and cruise speed.
- Calculating length of haul by dividing distance by cruise speed.
- Using lookups to classify flights to:
  - Time band categories (by flight time); and
  - Route Length categories (by length of haul).
- Excluding non-commercial flights in the NQP and flights granted dispensations[22].

3.7.6 It should be noted that the use of the 2014/15 raw flight data assumes that this is representative of the mix of aviation activity but it is subject to some variability due to the actual prevailing operational conditions that it represents. The process of aggregating the data to the flight grouping dimensions primarily serves the purpose of reducing the potentially distorting impact of any outliers in this pattern on the future forecasts, although it also has the benefit of reducing the size of data that needs to be handled within a spreadsheet application. The processing of the aircraft operations data will not have removed all of the impacts of these outliers, but reduces their potential impact to distort the results, and as a result is judged as providing a reasonable basis for the application of forecasts of growth in air travel and modelling the future impacts of changes to the NQP.

3.7.7 Finally, it should be noted that there are some relatively small limitations to this approach, where assumptions have been made and where the approach taken is not fully internally

[19] Average typical load factors have been applied for the shoulder periods based on guidance from Northpoint.

[20] These assumptions differ from the assumptions used by DfT in its fleet mix modelling for freight only flights at Stansted. This introduces some additional uncertainty around the results generated by the models for Stansted.

[21] There are some detailed differences between DfT's and SYSTRA's approaches. This introduces some further uncertainty around the results for scenarios which involve the displacement of existing flights in the shoulder period.

[22] Several hundred flights were also excluded from the shoulder period data since they could not be matched to the flight group dimensions due to missing data.

consistent (see footnotes 20 and 21 for examples of this) and this will contribute a small level of uncertainty surroundings the results generated by the models.

3.7.8 Cost and revenue component data was provided by RDC for each named aircraft type split by the following dimensions:

- Airport
- Arrival/Departure airport
- Carrier

3.7.9 The cost and revenue data was processed to provide aggregate data for the each of the flight group dimensions matching the 2014/15 operations data from the NQP and shoulder periods. Data were available directly for over 99% of the flight grouping combinations and in the limited instances where data was not fully available, unit (per flight) cost and revenue data was used from a closely matching flight group combination (for example, where data for a specific time period in the NQP was not available then the average unit data across all other time periods in the NQP was used). The aggregate cost and revenue data was appended to the matching aggregate records for aircraft operations to produce the model input data.

Airport Costs & Revenues

3.7.10 Separate data on the maximum take-off weight, NOx emissions per landing / take-off (LTO) cycle and the noise certification categories of the aircraft was added to the aircraft operations data to enable airport costs and revenues to be estimated for each flight.

3.7.11 The ways in which Airport Aeronautical Revenues accrue from Airlines are summarised in Table 3.4. These are extracted directly from the relevant airport's Schedule of Charges. These revenues are sub-divided into operations-related and passenger-related. Each of the three airports has its own way of assigning charges to airlines. For example, LHR and LGW levy landing / departing fees based on noise certification and NOx characteristics while STN levies such fees based on Maximum Total Weight Authorised (also known as Maximum Take Off Weight [MTOW]). LHR and STN levy a fee for Air Navigation Services but LGW does not. All three airports levy a departing passenger charge on a per passenger basis, while LGW also levies a fee per bag.

Table 3.4: Summary of Ways in which Airport Aeronautical Revenues accrue from Airlines

AIRPORT	OPERATIONS RELATED				PASSENGER RELATED	
	Landing/Departing Fee by Weight	Landing/Departing Fee by Noise Certification	Landing/Departing Fee by NOx characteristics	Air Navigation Services	Departing Baggage Charge	Departing Passenger Charge
LHR	N/A	Noise certification categories by aircraft type and Time Period	LTO NOx certification by aircraft type	Fixed charge per landing plus an increment per metric tonne	N/A	Per passenger varying by length of haul
LGW	N/A	Noise certification categories by aircraft type and Time Period	LTO NOx certification by aircraft type	N/A	Per bag	Per passenger
STN	MTOW calculation by Season	N/A	N/A	Charge per landing	N/A	Per passenger

3.7.12 Passenger Processing Costs incurred by Airports were derived in terms of the marginal operating costs per passenger. The same process was used for deriving the marginal operating costs per passenger at each of the three airports based on the airport's published accounts. This approach is approximate since some of the airport operating costs are relatively fixed and not proportionate to passenger numbers. That is, on an annual basis, this was calculated as follows:

- Derive "Operating Costs before Depreciation" by subtracting "Earnings Before Interest, Tax, Depreciation & Amortisation (EBITDA)" from "Revenue"; and
- Divide "Operating Costs before Depreciation" by the total number of passengers to give "Marginal Operating Costs per Passenger".

3.7.13 In the case of LGW and STN, Commercial Income per Passenger was extracted directly from the airport's published accounts. In the case of LHR, it was derived by dividing "Retail Income" by the total number of passengers.

3.7.14 The derived Airport costs and revenues are summarised in Table 3.5

Table 3.5: Derived Airport Costs and Revenues

COST/REVENUE ITEM	UNITS	AIRPORT		
		LHR	LGW	STN
Airport Costs				
Airport Marginal cost per Passenger	£ per passenger	15.43	8.96	7.51
Airport Revenues				
Airport Commercial Revenue from Passengers	£ per passenger	7.57	5.18	5.30

3.7.15 Operations-related charges are levied differently at the three airports as shown in the earlier Table 3.4. Derived airport revenues by MTOW at STN are shown in Table 3.6. Airport revenue from landing / departing charges at LGW are shown in Tables 3.7 and 3.8. Airport revenue from landing charges at LHR are shown in Table 3.9. As a simplifying assumption, the charges for 1 April to 31 October have been assumed for flights in the summer season and the charges for 1 November to 31 March have been assumed for flights in the winter season at STN and LGW, although it should be noted that these periods do not align exactly.

Table 3.6: Derived Airport Revenue from Landing Charges by MTOW at STN (£ per departure)

SEASON	16 – 55 TONNES	55 – 250 TONNES	> 250 TONNES
Summer	189.87	310.51	534.99
Winter	140.92	174.75	302.67

Table 3.7: Airport Revenue from Landing Charges at LGW (£ per landing)

	SUMMER			WINTER		
	Night	*Day*	*Shoulder*	*Night*	*Day*	*Shoulder*
Chapter 2	2752.06	903.29	2752.06	903.29	903.29	903.29
Chapter 3 High	1376.03	451.65	1376.03	451.65	451.65	451.65
Chapter 3 Base	660.07	216.65	660.07	216.65	216.65	216.65
Chapter 3 Minus	594.07	195	594.07	195.00	195.00	195.00
Chapter 4 High	561.07	184.16	561.07	0	0	0
Chapter 4 Base	561.07	184.16	561.07	0	0	0
Chapter 4 Minus	561.07	184.16	561.07	0	0	0

Table 3.8: Airport Revenue from Departing Charges at LGW (£ per departure)

	SUMMER			WINTER		
	Night	*Day*	*Shoulder*	*Night*	*Day*	*Shoulder*
Chapter 2	2752.06	1827.675	2970.35	903.29	903.29	903.29
Chapter 3 High	1376.03	913.84	1485.18	451.65	451.65	451.65
Chapter 3 Base	660.07	438.36	990.12	216.65	216.65	216.65
Chapter 3 Minus	594.07	394.535	891.12	195.00	195.00	195.00
Chapter 4 High	561.07	372.605	841.6	0	0	0
Chapter 4 Base	561.07	372.605	841.6	0	0	0
Chapter 4 Minus	561.07	372.605	841.6	0	0	0

Table 3.9: Airport Revenue from Landing Charges at LHR (£ per landing)

	SUMMER			WINTER		
	Night	*Day*	*Shoulder*	*Night*	*Day*	*Shoulder*
Chapter 2	22005.4	8802.2	8802.2	22005.4	8802.2	8802.2
Chapter 3 High	22005.4	8802.2	8802.2	22005.4	8802.2	8802.2
Chapter 3 Base	7335.1	2934.1	2934.1	7335.1	2934.1	2934.1
Chapter 4 High	4364.4	1745.1	1745.1	4364.4	1745.1	1745.1
Chapter 4 Base	3575.9	1430.4	1430.4	3575.9	1430.4	1430.4
Chapter 4 Minus	2090.5	836.2	836.2	2090.5	836.2	836.2

3.7.16 Airport charges per departing passenger are levied differently at the three airports. At LHR, they are sub-divided between European and other destinations and between origin-destination (as a simplifying assumption, it is assumed that the European charges are applied to flights under 3 hours, and the other charges are applied to fights longer of 3 hours or longer); and transfer/transit passengers (the transfer proportion is assumed to be 36% based on published information). At LGW, they are sub-divided between domestic and international destinations (the default domestic proportion is assumed to be 5% based on SYSTRA judgement of the schedules available from LGW). At STN a standard charge is levied on all passengers. Based on the relevant airport's Schedule of Charges and the assumptions made, the derived values are shown in Table 3.10.

Table 3.10 Airport Charge per Departing Passenger (£ per passenger)

AIRPORT	OD PASSENGERS < 3 HOURS	OD PASSENGERS > 3 HOURS	TRANSFER PASSENGERS < 3 HOURS	TRANSFER PASSENGERS > 3 HOURS
LHR	29.30	41.14	21.96	30.84
LGW	12.29	12.29	12.29	12.29
STN	11.09	11.09	11.09	11.09

3.7.17 At LGW additional charges are levied for the use of baggage and check-in facilities on both a per passenger and per ATM basis. On a per passenger basis these are:

- £0.11 per departing passenger
- £0.232 per departing passenger using check-in facilities

SYSTRA made an assumption that 85% of departing passengers would use check-in facilities based on expert judgement; hence, the calculated composite charge per departing passenger was:

£0.11 + £0.232 x 0.85 = £0.307

In addition, on a per departing ATM basis, these are £91.54 per ATM.

3.7.18 Other charges are calculated as follows:

Emissions Charges

These are levied by LGW and LHR per kg of NOx as follows.

- LGW: £2.8(for departures and arrivals)
- LHR: £8.57 (for arrivals)

Navigation Charges

These are levied by LHR on both a per landing and per metric tonne basis as follows:

- £80.53 per landing
- £1.08 per metric tonne

At STN, these are levied per landing as follows:

- £140.53 per landing

Public Account Impacts

3.7.19 Public Account impacts cover revenue from Air Passenger Duty (APD) and Value Added Tax (VAT). APD is levied on departing passengers and varies based on two distance bands (less than or greater than 2,000 miles from London). As a simplifying assumption, these distance bands were assumed to correspond to flight times (less than or greater than 3 hours[23]) for the purposes of input to the models. Estimated Public Account impacts of APD are summarised in Table 3.11.

Table 3.11: Summary of Public Account Costs: Air Passenger Duty - All Airports Year 2016 (£ per passenger)

	PASSENGER CLASS			
Route Length	First Class	Business Class	Premium Economy	Economy
< 3 hours	26	26	26	13
3 - 6 hours	146	146	146	73
6 - 9 hours	146	146	146	73
9 - 12 hours	146	146	146	73
12+ hours	146	146	146	73

[23] An approach using distance bands was used throughout the model was adopted to ensure that flights with common patterns of deployment were grouped together. This reduced both the potential impact of any outliers in the data and the size of the final models to a more manageable level.

3.7.20 VAT was estimated on a per passenger basis for airport expenditure including on shopping, car parking and other on-airport services using the current 20% rate. Commercial revenues were sourced from published accounts of the three London Airports (for STN, a breakdown of commercial revenues was not available, so the percentage breakdown for LGW was assumed in the absence of this data). Based on these, commercial revenues per passenger were derived. A "Margin" is then assumed based on SYSTRA's expert judgement (that is, the difference between purchase price and sales price) to determine the "Net VAT per Passenger". Only where these impacts are additional do they contribute to the results. The estimated Public Account impacts of VAT per passenger at the three airports is summarised in Table 3.12.

Table 3.12: Summary of Public Account Costs: VAT - By Airport Year 2015 (£ per passenger)

AIRPORT	VAT
LHR	0.55
LGW	0.44
STN	0.45

3.8 Peer Review and Quality Assurance Procedures

3.8.1 SYSTRA has conducted appropriate quality assurance for all analysis undertaken as part of this project in accordance with the DfT's guidance on the Quality Assurance of Analytical Modelling. Some of the procedures set out in this guidance are not appropriate for this specific assignment; only those which are appropriate have been undertaken. The various quality assurance processes and procedures undertaken are set out in further detail in **Appendix D**. Consistency of processing between the three models has been achieved by adopting a model development approach where a single template is always built for all airports and then populated with the input data from each of the airports. The overall results from running tests on models for all three airports have been reviewed by SYSTRA at each stage.

3.8.2 In particular, three levels of independent review have been undertaken:

- Review of the model structure, flow, processes, calculations, code, formulae and linkages by a senior member of SYSTRA staff unconnected with the development of the models;
- SYSTRA management team (Project Director and Project Manager) and Northpoint have reviewed the suitability of the model inputs and undertaken sense checks of the plausibility of the outcomes estimated by the models; and
- Peer review by a party outside the SYSTRA/Northpoint team to establish the robustness of the models to external challenge. The peer review was undertaken by Richard Bullock.

3.8.3 The model input files and analysis were also reviewed. Generally, this involved a review of the calculations and associated analysis by another member of the SYSTRA team. Some elements of the model inputs – ie. the airline and airport cost inputs - were also reviewed by Northpoint. Given the resource and time constraints of the study and the sheer volume of analysis required for the model input files, it was not possible to conduct an independent review of this component of the work.

3.8.4 The designated Peer Reviewer – Richard Bullock - has more than forty years' experience in the transport consultancy industry, including considerable experience in the field of airports and aviation. His experience includes studies of air/high-speed rail competition, liberalisation of aviation markets, airport surface access and airport masterplanning. From a technical perspective, Richard has considerable experience of developing and using complex models as well as reviewing the appropriateness of such models developed by others.

3.8.5 They key comments from the Peer Reviewer were as follows:

- Project has achieved its key objective of providing a methodological framework to assess economic impacts on airports, airlines and public accounts
- This is a relatively new area of work and the findings should be viewed as those from a research project
- Timescale and resource limitations of the project have meant that, by necessity, simplifying assumptions have been made
- The models as configured are quite large and require a considerable time to run; some streamlining is recommended
- Further development of the models could consider utilising additional data sources to validate the input assumptions and choice model parameters

3.8.6 The full text of the Peer Review can be found in **Appendix E**.

4. THE MODELLING APPROACH

4.1 Introduction

4.1.1 The flexible methodology to determine the impacts of possible changes to the night flights regime was built around the work undertaken in Stage One of the Study. This work which has provided an understanding of:

- Data availability: airline unit costs, route yields (from passengers and freight), aircraft operational timetable, the extent and breakdown of airport unit costs.
- Responses by airlines to changes in the night flights regime.
- Potential responses by air travel users (air freight users and passengers).
- The specification of the range of potential policy scenarios to be tested, noted by the indicative scenarios.

4.1.2 The stakeholder engagement, data and literature review confirmed:

- How the scale of impacts is affected by the nature and extent of changes;
- The range of responses by the key economic actors; and
- The sources of information for the volumes of activity and unit cost and revenue components incurred by each economic actor.

4.2 Model Scope and Structure

4.2.1 The models structure is illustrated in Figure 2 and its computations and high level computational flow summarised as follows for each year in the modelling period:

- The basis for the models is the actual Base year (2014/15) **commercial aircraft operations** to which **base year commercial unit revenues and costs** are added (this covers airline costs and revenues, airport costs and revenues, and APD and VAT).
- A set of **unconstrained aircraft movements** in future years are calculated by applying the **aviation growth factors** and the assumed future **fleet mix** to the base year operations.
- **Unconstrained scenario revenues and costs** in future years are calculated as a reference point for the impact analysis and a basis for computing the revenues and costs for the night flights policy scenario under consideration.
- The **commercial response rules** are then 'run' where there are constraints on the total operations and / or QC under the night flights regime policy scenario under consideration compared to the unconstrained scenario. The scale and nature of the responses computed reflect the commercial response rule selected.
- The models then generate a constrained scenario for aircraft operations, demand, costs and revenues[24]. That is, the total operations, demand, costs and revenues under the night flights regime policy scenario under consideration.
- The **impact** of each night flights regime policy scenario (including the Baseline) is computed relative to the unconstrained scenario.[25]

4.2.2 In future years, the models estimate the total revenues and costs for each flight grouping (i.e. (airline costs and revenues, airport costs and revenues, and APD and VAT) based on the number of flights estimated in the flight grouping, and the average revenues and cost per flight assumed for the flight grouping.

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[24] This response scenario will be the same as the unconstrained scenario where the volume of QC and operations from the unconstrained scenario can be accommodated within the night noise regime being tested.
[25] The impact of the test scenario relative to the Baseline is determined from a comparison between outputs.

4.2.3 Where there are flights in a flight grouping in the base year, the average revenues and costs per flight assumed for the flight grouping in future years are based on the average revenues and costs per flight in the flight grouping in the base year, and whether any change in the value of the average revenues and costs per flight in real terms is assumed. In contrast, where changes in the fleet mix in future years give rise to a flight grouping that is not present in the base year data, the average revenues and costs per flight assumed for the flight grouping in future years are based on the average revenues and costs per flight for closely matching flight groupings in the base year.

4.2.4 Therefore, in the models, the average revenues and costs per flight assumed for each flight grouping are estimated by progressively relaxing the disaggregation of the flight grouping dimensions in the order shown in the example table for LHR below. If there are flights in a flight grouping in the base year, level 1 is used. If not, the average costs and revenues per flight are estimated at a more aggregate level; level 2 drops time band, level 3 drops time band and season and so on.

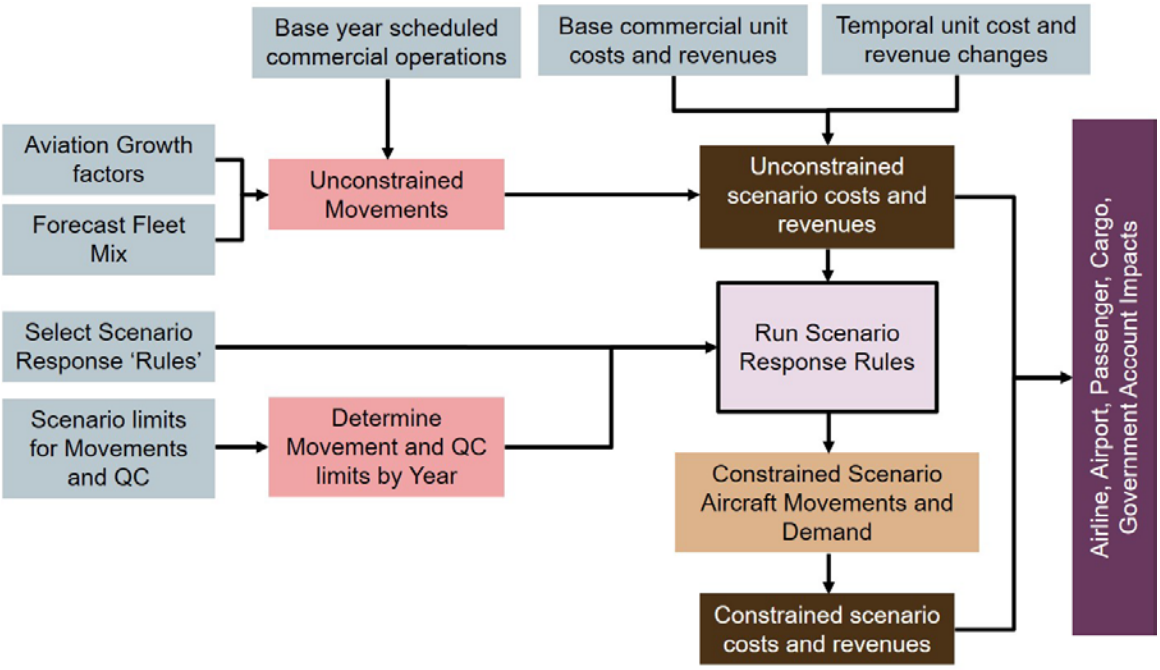
4.2.5 If a new QC category is introduced in any future year(s) that is not used in the base year, the average costs and revenues per flight assumed for all flights with this QC are based on the averages for flights in the next lowest QC category in level 7 (e.g. if a QC is introduced between 0 and 0.25, the models would use the averages for flights at the airport in the base year with a QC of 0).

4.2.6 This method ensures that the models estimate the total revenues and costs for each flight grouping even if there are no flights in certain flight groupings in the base year.

Level	Dimensions							
	Airport	Season	Time Band	Route Length	Carrier Type	Size Type	Direction	Quota
1	LHR	W	1	1	CH	1	A	0
2	LHR	W		1	CH	1	A	0
3	LHR			1	CH	1	A	0
4	LHR			1	CH	1		0
5	LHR				CH	1		0
6	LHR					1		0
7	LHR							0

4.2.7 The models also provide the functionality to allow the user to specify the maximum QC allowed for flights in the NQP in each season in each year of the modelling period. As a result, no flights with a QC value greater than the specified maximum will be forecast under the night flights regime policy scenario. In particular, the models assume that any flights with a QC value greater than the specified maximum which are estimated to take place under the unconstrained scenario would not take place under the night flights regime policy scenario.

Figure 2: Schematic Illustration of the Model Structure



Response Modelling

4.2.8 The commercial response modelling is invoked when the unconstrained scenario exceeds either the **Movement limit or quota limit** under a Baseline or Policy Test Scenario**.** The model seeks to meet the constraint imposed by the most restrictive of these two limits.

4.2.9 A number of potential responses to meet movement and QC limits (and where necessary reduce the movements or QC from the unconstrained scenario) are modelled[26]:

- Reduction in flights in the NQP only – no alternatives available
  - Pro-rata reduction applied to all flight groups
- Re-scheduling of flights from the NQP to the shoulder periods is possible, with sub-options that this response either
  - Does not require displacement of shoulder period flights
  - Requires displacement of shoulder period flights
- There is the potential for demand to re-route
  - to another UK airport, requiring a longer surface access leg; or
  - to a non-UK airport, requiring a transfer to take another flight into the constrained airport
- Where the constraint bites on the QC limit, there is the potential to switch to quieter aircraft - this involves a simplified consideration of the potential for the airlines to switch the fleet mix within each aircraft size type to increase the proportion of operations by aircraft with a QC lower than the average QC and a corresponding reduction in the

[26] Each 'Run' of the model calculates all of these outcomes and the user is required to select the responses for which the impacts are computed. Thus it is straightforward for the user to review the sensitivity of the outcome to the response scenario respected and/or apply factors to reflect their view of the likelihood of each outcome and produce a combined scenario.

proportion of operations by aircraft with a QC higher than the average QC (there is also a variant that this does this within each aircraft size type and carrier group combination).

4.2.10 In the models, the night noise policy scenario and any constraints implied by this in each forecast year is the trigger for subsequent action by the combination of economic actors – the models seek to approximate an outturn balanced position in each forecast year that is a combination of the dynamic market actions and reactions that would occur in reality.

4.2.11 The models are seeking to capture the reality of the airports and airlines agreeing changes to schedules and this has been modelled by giving the model user the flexibility to select which of the above responses is assumed. This can then be varied for testing purposes by the model user to reflect a range of potential agreements (e.g. in terms of the flight groups of flights affected, taking into account their respective commercial positions and the expected and actual responses of consumers (comprising passenger and freight demand)).

4.2.12 In modelling terms a sequence of processing is required such that the models can ultimately compute the outturn of changes to flights made by a flight group, and then the cost and revenue impacts for airlines and airports, and finally the impacts on passengers and the public accounts.

4.2.13 The 'driver' for the implementation of the commercial responses varies by the element of the response:

- The computation of the impacts of the 'Reduction in flights' or 'Switch to Quieter Aircraft' is modelled as a hard constraint with the response driven from a requirement on the airline/airport to provide operations within the constraints of the policy scenario. The implications for passengers and other 'economic actors' are then a direct consequence of the changes in flights in each flight grouping to meet the constraints.

- When considering the 'second order' responses, including the outturn modelling of a displacement of the flights from the shoulder period and potential options to travel via UK and non-UK airports, the models consider the aggregate behaviour of passengers when considering each of these options. Here the models determine the proportion of passengers which might select an alternative to the night flight option that is no longer available based on a perception of the additional travel penalties that those options imply.

4.2.14 The following tables provide a descriptive summary of the range of scenario responses computed by the models which may be selected prior to computing the overall impacts. All comparisons are made relative to the unconstrained scenario.

Reduction in flights in the night quota period (NQP)

Descriptions below are for the cost and revenue impacts and modelling for flights in the NQP

	Airlines	Passengers	Cargo Users	Airports	Government
How is each group impacted?	The reduction in the number of movements in the NQP will impact on airline costs and revenues from these flights. The following approach is used to determine which flights are removed from the NQP: Equal proportion of excess unconstrained movements from each flight group removed from NQP.	Passenger numbers in each flight group are assumed to be reduced in proportion to the reduction in the number of movements in the each flight group. Passengers will also be affected by any change in air fares.	Freight volumes in each flight group are assumed to be reduced in proportion to the reduction in the number of movements in each flight group. Cargo users will also be affected by any changes to pricing.	The reduction in the number of movements in the NQP will impact on airport costs and revenues.	Changes to passenger numbers in the NQP will impact on air passenger duty and VAT receipts.
How are the economic impacts estimated in the models?	Airline impacts are estimated assuming that the average airline costs and revenues per movement in each flight group remain unchanged. Total airline costs and revenues in the NQP are therefore estimated to be reduced in proportion to changes in movements in each flight group. The benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand are estimated separately.	The change in economic surplus for passengers in the NQP is estimated in the models taking account of the change in passenger numbers and any additional fares required to obtain the constrained level of demand.	No economic impacts on cargo users are estimated in the models.	Airport impacts are estimated assuming that the average airport costs and revenues per movement in each flight group remain unchanged. Total airport costs and revenues in the NQP are therefore estimated to be reduced in proportion to changes in movements in each flight group. The benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand are estimated separately.	Impacts on APD and VAT are estimated based on the change in passenger numbers in the NQP, and seek to take account of the impact of any additional fares required to obtain the constrained level of demand on VAT receipts.

Flights rescheduled from the night quota period (NQP) to the shoulder periods
Descriptions below are for the cost and revenue impacts and modelling for the flights that are rescheduled to the shoulder periods from the NQP

	Airlines	Passengers	Cargo users	Airports	Government
How is each group impacted?	Airlines will experience costs and revenues from the flights that now take place in the shoulder periods. Passenger flights removed from the NQP are assumed to transfer to the shoulder periods in proportion to the number of passengers estimated to continue using the airport in each flight group despite the flights being rescheduled to the shoulder periods. (For this analysis, flights are aggregated by the following criteria: Season, Route Length, Carrier Type, Size Type, Direction and QC.) No freight only flights are assumed to be rescheduled to the shoulder periods.	Passengers travelling on flights rescheduled to the shoulder periods are assumed to experience a time penalty from the change in flight time. A proportion of unconstrained NQP passengers will be deterred from travelling on flights rescheduled to the shoulder periods due to the change in flight times. The number of passengers using flights rescheduled to the shoulder periods is estimated taking account of the assumed average re-timing for travel time based on moving the flights to the earliest available slots. Passengers will also be affected by any change in air fares.	No freight only flights are assumed to be rescheduled to the shoulder periods. The total freight volume on passenger flights transferred to the shoulder periods is determined based on the proportion of movements in each flight group rescheduled to the shoulder periods. Cargo users will also be affected by any changes to pricing.	Airlines will experience costs and revenues from the flights that now take place in the shoulder periods.	Air passenger duty and VAT receipts will be impacted.
How are the economic impacts estimated in the models?	Airline impacts are estimated assuming that the average airline costs and revenues per movement in each flight group remain unchanged. Total airline costs and revenues for flights rescheduled to the shoulder periods are therefore estimated based on the proportion of movements in each flight group rescheduled to the shoulder periods. A simplified approach has been used to separately estimate the benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand under this scenario; this does not distinguish between flights in the NQP and flights that are rescheduled to the shoulder periods.	The change in economic surplus for passengers who travel on flights rescheduled to the shoulder periods is estimated in the models taking into account that fares applicable to the night quota period are assumed to be maintained and remaining passengers are assumed to experience a time penalty from switching to a later or earlier flight.	No economic impacts on cargo users are estimated in the models.	Airports impacts are estimated assuming that the average airport costs and revenues per movement in each flight group remain unchanged. Total airports costs and revenues for flights rescheduled to the shoulder periods are therefore estimated based on the proportion of movements in each flight group rescheduled to the shoulder periods. A simplified approach has been used to separately estimate the benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand under this scenario.	The change in taxation receipts has been estimated using a simplified approach under this scenario; this does not distinguish between flights in the NQP and flights that are rescheduled to the shoulder periods.

Existing flights displaced from the shoulder periods due to flights being rescheduled from the night quota period (NQP) to the shoulder periods

Descriptions below are for the cost and revenue impacts and modelling for the existing flights that are displaced from the shoulder periods such that the unconstrained scenario flights displaced from the NQP can be accommodated

	Airlines	Passengers	Cargo users	Airports	Governments
How is each group impacted?	Changes to the number of existing flights in the shoulder periods will impact on airline costs and revenues. Existing flights in the shoulder periods are assumed to be reduced pro rata to ensure the number of flights displaced from the NQP can be accommodated in the schedule.	Passenger numbers on existing flights in the shoulder period factored down in proportion to reduction in the number of flights. Passengers continuing to travel will also be affected by any additional fares required to obtain the constrained level of demand in the shoulder periods.	Cargo volumes on existing flights in the shoulder periods factored down in proportion to reduction in the number of flights. Cargo users will also be affected by any changes to pricing.	Changes to the number of existing flights in the shoulder periods will impact on airport costs and revenues.	Air passenger duty and VAT receipts will be impacted.
How are the economic impacts estimated in the models?	Airline impacts are estimated assuming that the average airline costs and revenues per movement in each flight group for existing flights in the shoulder periods remain unchanged. The reduction in the total airports costs and revenues for existing flights in the shoulder periods are therefore estimated based on the number of flights displaced in each flight group. (For this analysis, flights are aggregated by the following criteria: Season, Route Length, Carrier Type and Direction.) The benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand are estimated separately.	The change in economic surplus for passengers on existing flights in the shoulder periods is estimated in the models taking account the change in passenger numbers and any additional fare required to obtain the constrained level of demand.	No economic impacts on cargo users are estimated in the models.	Airport impacts are estimated assuming that the average airport costs and revenues per movement for existing flights in the shoulder periods in each flight group remain unchanged. The reduction in the total airports costs and revenues for existing flights in the shoulder periods are therefore estimated based on the number of flights displaced in each group. The benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand are estimated separately.	Impacts on APD and VAT receipts are estimated based on the change in passenger numbers on existing flights in the shoulder periods, and seek to take account of the impact of any additional fares required to obtain the constrained level of demand on VAT receipts.

Flights re-scheduled from the NQP to another UK Airport
Descriptions below are for the cost and revenue impacts and modelling for the flights that are rescheduled to another UK airport

	Airlines	Passengers	Cargo users	Airports	Governments
How is each group impacted?	Airlines will experience costs and revenues from the flights that now take place at other UK airports. Passenger flights removed from the NQP are assumed to be rescheduled to other UK airports as a proportion of the number of passengers using the airport in unconstrained scenario in each flight group. (For this analysis, flights are aggregated by the following criteria: Season, Route Length, Carrier Type and Direction.) No freight only flights are assumed to be rescheduled to other UK airports.	Passengers using flights rescheduled to other UK airports are assumed to experience a time penalty from additional surface access travel time to get to/from the other airport. The proportion of origin-destination passengers which will 're-locate' to another UK airport is estimated based on modelling the impact of how an additional surface access travel time will impact on demand. In addition, transfer passengers are assumed not to continue flying on flights rescheduled to other UK airports. Therefore, the number of passengers using flights rescheduled to other UK airports is estimated based on the assumed average travel time change and the removal of transfer passengers. Passengers will also be affected by any change in air fares	No freight only flights are assumed to be rescheduled to other UK airports. The total freight volume on passenger flights transferred to other UK airports is estimated based on the proportion of movements in each flight group rescheduled to other UK airports. Cargo users will also be affected by any changes to pricing.	Other UK airports will experience costs and revenues from the flights that now take place at other UK airports.	Air passenger duty and VAT receipts will be impacted.
How are the economic impacts estimated in the models?	Airline impacts are estimated assuming that the average airline costs and revenues per movement in each flight group remain unchanged. Total airline costs and revenues for flights rescheduled to other UK airports are therefore estimated based on the proportion of movements in each flight group rescheduled to other UK airports. A simplified approach has been used to separately estimate the benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand under this scenario; this does not distinguish between flights in the NQP and flights that are rescheduled to another UK airport.	The change in economic surplus for passengers who travel on flights rescheduled to other UK airports is estimated in the models taking into account that fares applicable to the night quota period are assumed to be maintained and passengers travelling to other UK airports are assumed to experience a time penalty from additional surface travel time.	No economic impacts on cargo users are estimated in the models.	Airports impacts are estimated assuming that the average airport costs and revenues per movement in each flight group remain unchanged. Total airport costs and revenues for flights rescheduled to other UK airports are therefore estimated based on the proportion of movements in each flight group rescheduled to other UK airports. A simplified approach has been used to separately estimate the benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand under this scenario.	The change in taxation receipts under this scenario has been estimated using a simplified approach; this does not distinguish between flights in the NQP and flights that are rescheduled to another UK airport.

Flights accommodating demand that is re-routed via a non-UK airport
Descriptions below are for the cost and revenue impacts and modelling for additional flights which transport passengers where demand is re-routed via a non-UK airport

	Airlines	Passengers	Cargo users	Airports	Government
How is each group impacted?	Airlines will experience costs and revenues for flights to / from other non-UK airports transporting passengers who transfer at a non-UK airport on their journey to / from the affected UK airport and arrive at / depart from the affected UK airport outside the NQP. The non-UK to non-UK leg of the revised journey is excluded from this assessment. No cargo is assumed to be re-routed to non-UK airports. No passenger demand for low-cost and charter passenger flights is assumed to be re-routed to non-UK airports. (Low-cost flights or charter flight operate as solely point-to-point services not packaged into a coordinated network of individual flight leg and transfers by these airlines.) So, only passenger demand for full service flights is assumed to have the potential to be re-routed. The number of full service passenger flights required to meet this demand is estimated based on the number of passengers estimated to re-route to travel via a non-UK airport in each flight group. The mix of flight groupings used by passengers who continue to travel via a non-UK airport is influenced by the assumptions made about the proportion of flights transferring these passengers between the affected UK airport and the non-UK airport that fall in each route length category. (For this analysis, flights are aggregated by the following criteria: Season, Route Length, Carrier Type, Size Type, Direction and QC.)	Full service passengers using these flights are assumed to be subject to an additional transfer time penalty. The proportion of origin-destination passengers which continue to use these flights is estimated based on modelling the impact of the transfer penalty on demand. In addition, transfer passengers are assumed not to use these flights. Therefore, the number of passengers using these flights is estimated based on the assumed average travel time change and the removal of transfer passengers. Passengers will also be affected by any change in air fares	No cargo is assumed to be transported on these flights. Cargo users will also be affected by any changes to pricing.	UK Airports will experience costs and revenues from these flights.	Air passenger duty and VAT receipts will be impacted. For example, the loss of APD from the NQP flights will be partially offset by APD from other flights carrying the passengers who continue to travel via a transfer airport outside of the UK.

	Airlines	Passengers	Cargo users	Airports	Government
How are the economic impacts estimated in the models?	Airline impacts are estimated assuming that the average airline costs and revenues per movement in each flight group remain unchanged (except for cargo revenues which are assumed to be zero). A simplified approach has been used to separately estimate the benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand under this scenario; this does not distinguish between flights in the NQP and flights which transport passengers where demand is re-routed via a non-UK airport .	The change in economic surplus for passengers who travel on these flights is estimated in the models taking into account that fares applicable to the night quota period are assumed to be maintained and the transferring passengers face an increased transfer time penalty.	No economic impacts on cargo users are estimated in the models.	Airports impacts are estimated assuming that the average airport costs and revenues per movement in each flight group remain unchanged. A simplified approach has been used to separately estimate the benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand under this scenario.	The change in taxation receipts under this scenario has been estimated using a simplified approach; this does not distinguish between flights in the NQP and flights which transport passengers where demand is re-routed via a non-UK airport.

4.2.15 The switch to quieter aircraft response can be used where there is a binding limit on the total QC in either the Winter or Summer seasons. A simplified iterative modelling mechanism is employed to seek a change in the average QC per movement from that in the unconstrained scenario to equal that required in the constrained scenario. The impact is that the number of movements by aircraft with QC less than the average are increased and the number of movements by aircraft with QC higher than the average target are reduced.

4.3 Modelling of Demand (Passenger) Responses

4.3.1 The principles of the modelling of the impacts on passenger numbers where constraints exist under the policy scenario that is being modelled are that:

- It is assumed that there are no alternative travel routes. Therefore, where the unconstrained level of passenger demand in the NQP exceeds that allowed under the policy scenario, it is assumed that any excess passengers in the NQP are effectively 'priced-off'. To implement this, a shadow price/fare is estimated for each flight group which represents the additional fare required to reduce passenger demand in order to meet the constraint. This 'hard' fixed constraint is applied in all cases where the constraint 'bites' and the corresponding shadow fare is calculated that is needed to meet this constraint.

- The model also enables one of the following options to be selected by the model user as an input assumption. Based on this assumption, the model estimates the proportion of the excess passengers that would continue to travel by the selected option if they can no longer travel in the NQP:

  1) flights in the shoulder period where the additional flights needed to accommodate these passengers can be incorporated within the existing schedule;

  2) flights in the shoulder period where the additional flights needed to accommodate these passengers cannot be incorporated within the existing schedule, and require that flights in that period do not operate and passengers carried on those flights are lost;

  3) travelling via a surface access leg from an alternative UK (conservatively assumed London) airport; and

  4) travelling via a transfer at a non-UK airport.

4.3.2 The model is therefore effectively applied in two stages: firstly to determine the number of passengers who can continue to travel in the NQP and then to determine whether the passengers that cannot be accommodated in the NQP will continue to travel in some other way, reducing the overall dis-benefit to passengers.

4.3.3 The implementation approach for this draws on the DfT National Passenger Allocation model (NAPAM) coefficients to provide a model and coefficients to allow the representation of the impacts of commercial responses. NAPAM is an aggregate multinomial logit model which distributes passengers across a set of available route options based on their relative costs. Within this research study the model has been applied in incremental form, that is to adjust from the unconstrained situation.

4.3.4 The generic form of the model used to estimate the proportion of demand not accommodated in the NQP under a policy scenario which would switch to one of alternative modes of travel described above (e.g. travelling via a transfer at a non-UK airport) is explained below:

$$\boldsymbol{D' = D\, e^{\beta \Delta U}}$$

where

D is the passenger demand in the unconstrained scenario which cannot be accommodated in the NQP under the policy scenario by flight grouping.

D' is the proportion of D which would switch to the alternative mode of travel under the policy scenario by flight grouping.

β is the logit model sensitivity parameter applied to each of the cost component to determine the change in passenger demand.

ΔU is the additional cost to use the alternative mode of travel (e.g. a travel time penalty though either additional effective waiting time for a re-timed flight, additional surface access time or transfer time penalty).

A breakdown between the different cost components that could be used in this generic equation is provided below.

$$\beta\Delta U = \beta_{access}\Delta U_{access} + \beta_{fare}\Delta U_{fare} + \delta_{re-time}\beta_{wait}\Delta U_{wait} + \beta_{transfer}\Delta U_{transfer}$$

4.3.5 The **β** sensitivity parameters for this model are based on the UK Business and Leisure basic parameters from NAPAM[27] as follows:

PARAMETER	DEFINITION	BUSINESS VALUE	LEISURE VALUE
Surface Access Cost (β_{access})	VOT * Additional surface access travel time	-0.0303	-0.134
Air Fare (β_{fare})		-0.000449	-0.0151
Cost of (Direct) Wait Time (β_{wait})	VOT * Displacement of travel time to the shoulder periods	-0.09	-0.103
Cost of Transfer Time ($\beta_{transfer}$)	VOT * Additional transfer time	-0.0503	-0.187
A	Coefficient in the wait time formulation	0.2	0.4
Re-timing adjustment ($\delta_{re-time}$)	Derived parameter applied to wait time per hour of schedule displacement	0.0625	0.0625

Where VOT is the value of travel time.

4.3.6 The original model formulation used a measure of wait time (W) based on travel frequency (F) as follows:

[27] Peer Review of NAPALM, John Bates Services, October 2010: Pages 17 and 22 tabulating the recommended models for Business and Leisure
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4506/review-napalm.pdf

$$W = \frac{1}{2} * \frac{16}{F} * (1 - (1 - a)^F)$$

4.3.7 In this model the passenger displacement from the NQP to the shoulder periods is based on the assumption that there is a frequency (F) of one flight per day and there is no change in the underlying frequency of flights. Therefore this formulation needs to be adapted to reflect that the displacement time to be modelled is merely a re-timing of the flight rather than a change in frequency represented in the original parameter derivation. This model considers the dis-benefit of the displacement of the 'wait time' which has been assumed to be equivalent to a proportion of the wait time penalty for each hour of displacement between the NQP and the Shoulder period. This has been achieved by introducing a 're-timing adjustment' parameter to the formulation.

4.3.8 The 're-timing adjustment' is achieved here by applying the formula for W based on a single flight per day leading to values for W of 1.6 and 3.2 hours respectively for business and leisure. A 'penalty per hour of displacement' is calculated on the basis of an assumed 16 hour period in which flights might take place; so each one hour displacement of a flight in a 16 hour day is equivalent to a penalty of 0.1 and 0.2 hours respectively for business and leisure travellers. These factors are used to calculate the relative impact (and penalty) associated with each hour of displacement of the flight schedule. This is applied by applying a factor ($\delta_{re\text{-}time}$ shown above) of 0.1/1.6 (=0.0625) for Business and 0.2/3.2 (=0.0625) for Leisure to the 'Cost of (Direct) Wait Time (βwait)' parameters shown in the table above.

4.3.9 A key assumption here is that passengers prefer flying in the NPQ and this may not always be the case. Standard values of travel time for Business and Leisure passengers from WebTAG are used in the models[28].

Calculation of the Shadow Fare required to Constrain Demand in the NQP

4.3.10 Where the night flight policy scenario being tested requires the number of aircraft operations in a flight group to be reduced to satisfy the constraints on the number of operations in the NPQ, no adjustment to load factors is assumed. Thus the constraint (factor) applied to determine the number of operations is applied directly to reduce the number of passengers. This computation is made for each individual flight grouping in the model.

4.3.11 The shadow fare is calculated as the additional fare that is required to obtain the level of demand required to meet the constraints in the policy scenario from the unconstrained position. It is effectively calculated from the proportion of passengers retained and the air fare parameter from the logit model. Using this information it is possible to calculate the effective incremental shadow fare penalty which would have been required to constrain the number of passengers continuing to travel in the NPQ under the policy scenario to the necessary amount. A separate shadow fare is calculated each year for Business and Leisure travel classes for each flight grouping.

4.3.12 The shadow fare is calculated as = ln (D'/D) / β_{fare} where D is the number of passengers that would travel in the NQP under the unconstrained scenario for the flight grouping; and D' is the number of these passengers that could continue to travel in the NQP under the policy scenario for the flight grouping.

4.3.13 When implementing this, SYSTRA has assumed that the shadow fares for each flight grouping should be capped at the value of the average fare for the flight grouping in the unconstrained scenario. Furthermore, it is assumed that the passenger willingness to pay associated with the model parameters used to calculate the shadow fare would change over time by default

[28] Source: WebTAG: TAG data book, July 2016

in line with changes in real GDP per person. It is possible for the user to vary this assumption in the models.

Proportion of passengers switching to Shoulder period flight

1) Additional flights needed to accommodate these passengers can be incorporated within the existing schedule

4.3.14 The generic logit model used to calculate the proportion of demand not accommodated in the NQP which would switch to a flight in the shoulder period uses the following inputs:

$\beta_{re\text{-}time}$ is the logit model sensitivity parameter applied to the value of the additional effective waiting time for a re-timed flight. This is calculated as the product of $\boldsymbol{\delta_{re-time}}$ * β_{wait} from the table above.

ΔU_{wait} is the assumed value of the displacement of travel time to the shoulder periods for the flight grouping multiplied by the value of time.

Proportion of passengers switching to Shoulder period flight

2) additional flights needed to accommodate these passengers cannot be incorporated within the existing schedule

4.3.15 Based on the calculation of the proportion of passengers switching to a shoulder period flight, the number of aircraft operations to be accommodated in the shoulder period is computed. Where this response is assumed to require displacement of existing flights that are scheduled for the shoulder periods then these flights are factored down by the appropriate volume of traffic. In this case there is no modelling of a further passenger response; so the passengers are assumed lost and not further re-distributed (ie a worst case scenario) and a corresponding additional shadow fare is calculated as a measure of pricing-off these shoulder period passengers. A separate shadow fare is calculated each year for Business and Leisure travel classes for each flight grouping.

4.3.16 The shadow fare is calculated as = ln (D'/D) / β_{fare} where D is the number of passengers that would travel in the shoulder periods under the unconstrained scenario for the flight grouping; and D' is the number of these shoulder period passengers that could continue to travel in the shoulder periods under the policy scenario for the flight grouping.

4.3.17 When implementing this, SYSTRA has assumed that the shadow fares for each flight grouping should be capped at the value of the average fare for the flight grouping in the unconstrained scenario. Furthermore, it is assumed that the passenger willingness to pay associated with the model parameters used to calculate the shadow fare would change over time by default in line with changes in real GDP per person. It is possible for the user to vary this assumption in the models.

Proportion of passengers switching to Alternative UK Airports

4.3.18 The generic form of the logit model used to calculate the proportion of demand not accommodated in the NQP which would switch to an alternative UK airport, as a less preferred option to a direct flight, uses the following inputs:

β_{access} is the logit model sensitivity parameter applied to the value of the additional surface access time

ΔU_{access} is the assumed value of the additional surface access time multiplied by the value of time.

Proportion of passengers switching to Alternative non-UK Airports

4.3.19 The generic form of logit mode used to calculate the proportion of demand not accommodated in the NQP which would transfer at an alternative non-UK airport, as a less preferred option to a direct flight, uses the following inputs:

$\beta_{transfer}$ is the logit model sensitivity parameter applied to the value of the transfer time.

$\Delta U_{transfer}$ is the assumed average time to transfer between flights multiplied by the value of time.

4.4 Impact Assessment Calculations

4.4.1 Much of the impact assessment calculation methodology used in the model is bespoke; that is, it has been created specifically for the purposes of this model. Wherever possible, the methodology has sought to follow the DfT WebTAG guidance.

4.4.2 The implementation of the models has necessitated that the economic impacts have been estimated initially by comparing the outputs from the unconstrained situation. On this basis the impacts from the Baseline scenario and each policy test scenario are collated in aggregate before being compared to provide an indication of the impacts between the policy test scenarios and the Baseline (which is the continuation of the existing night flight regime for the purposes of this report). Thus, in the following computations of economic impacts for passengers, producers and public accounts, the reference situation is the unconstrained situation.

Passengers

4.4.3 For **passengers**, a simplified approach has been adopted for calculating the change in consumer surplus using the Rule of a Half. The principles set out in the reference "TUBA – General Guidance and Advice" – DfT[29] have been adapted to the specific requirements of this Study.

4.4.4 In the modelling approach adopted, passenger dis-benefits will result from a combination of the:

- shadow fares which are computed (as noted above) for each flight grouping to represent the effective price required to constrain demand in the NQP to the level required by the policy scenario, including that for the Baseline; and
- penalty experienced by passengers selecting an available alternative, noting that the availability of each alternative has been considered independently in the model.

4.4.5 The primary dis-benefits to passengers will be due to any constraints in the NQP implied by the policy regime relative to the unconstrained night flight situation. SYSTRA considers that the shadow fare approach used directly in calculating the economic dis-benefit for business and leisure passengers for this situation is consistent with that used for the Airports Commission analysis for London Airports. The calculation of this economic dis-benefit for passengers is based on the principle that the shadow fare applies to passengers who continue to travel in the NPQ; and those that are displaced no longer travel or travel via an alternative.

[29] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492792/tuba-general-guidance-and-advice.pdf

4.4.6 A further impact would be realised in the situation where any flights that are displaced to the shoulder periods then displace existing flights in the shoulder periods. Similarly to the above, shadow fares are calculated for each flight grouping and used to estimate the economic dis-benefit to those passengers who are displaced from the shoulder periods.

4.4.7 Overall, the modelling is based on the construct that passengers will either 'continue' or 'not continue' to travel in the NQP depending on the extent of the limit being modelled. Where the commercial response scenarios include an alternative (ie displacement to the shoulder, transfer to another UK airport or transfer at a non-UK airport) then the proportion continuing to travel is split between:

- those passengers continuing to travel in the NQP and experiencing the shadow fare as a penalty; and
- those passengers travelling via the commercial response alternative offered as a response scenario.

4.4.7 In the situations where the commercial response alternative is offered then the passenger dis-benefit is calculated as the composite of the costs of these two alternatives proportionate to the number of passengers assessed as continuing to travel in the NQP or via the alternative.

4.4.8 The principles of the approach have been discussed and reviewed within SYSTRA and by the peer reviewer. Both have assessed that the approach provides a reasonable approach within the context of this research study.

4.4.9 SYSTRA considers that the computations of the passenger impacts for each of the commercial response scenarios modelled is consistent with WebTAG.

4.4.10 The calculations used to estimate the change in consumer surplus under the night flights policy scenario compared to the unconstrained scenario for each of the commercial response scenarios are described below. These impacts are calculated separately for each flight grouping in the models. In addition, within each flight grouping, the calculations are further disaggregated by ticket type in the models (i.e. first class, business class, premium economy and economy).

Change in consumer surplus when there is a reduction in flights in the NQP and no alternatives are available

Business	$\frac{1}{2}(1+t)\sum(pax_u + pax_s)(-\Delta U_{fare})$
Leisure	$\frac{1}{2}\sum(pax_u + pax_s)(-\Delta U_{fare})$
Where	
t	average level of indirect taxation in the economy
pax_u , pax_s	number of (business or leisure) passengers travelling in the NQP under the unconstrained scenario (u) and the night flights policy scenario (s) for the flight grouping (as appropriate) (by ticket type)
ΔU_{fare}	shadow fare for (business or leisure) passengers travelling in the NQP in the night flights policy scenario (s) for the fight grouping (as appropriate)

Change in consumer surplus when there is a reduction in flights in the NQP and there is the potential for the retiming of flights from the NQP to the shoulder periods (Does not require displacement of shoulder period flights)

Business	$\frac{1}{2}(1+t)\sum(pax_u + pax_s)(-\Delta C_s^*)$
Leisure	$\frac{1}{2}\sum(pax_u + pax_s)(-\Delta C_s^*)$
where	
t	average level of indirect taxation in the economy
pax_u , pax_s	number of (business or leisure) passengers travelling in the NQP under the unconstrained scenario (u) and the night flights policy scenario (s) for the flight grouping (as appropriate) (by ticket type)
ΔC_s^*	The composite (logsum) costs of the shadow fare under the night flights policy scenario (s) and the displacement time penalty for the flight grouping: $$\frac{1}{\beta_{fare}} Ln\left[\left(e^{\beta_{wait}\delta_{re-time}\,\Delta U_{wait}}\right) * (1 - p_s) + \left(e^{\beta_{fare}\Delta U_{fare}}\right) * p_s\right]$$ Using the parameters defined above for the passenger choice formulation and p_s is the proportion of passengers continuing to travel in the NQP of those continuing to travel in the NQP and those passengers continuing to travel on flights retimed to the shoulder periods i.e. $p_s = pax_s / (pax_s + pax_{rsp})$ where pax_{rsp} is the number of passengers continuing to travel on flights retimed to the shoulder periods.
ΔU_{fare}	shadow fare for (business or leisure) passengers travelling in the NQP in the night flights policy scenario (s) for the fight grouping (as appropriate)

Change in consumer surplus when the retiming of flights to the shoulder periods requires displacement of existing flights during the shoulder periods

In addition to the change in consumer surplus when there is a reduction in flights in the NQP and there is the potential for the retiming of flights from the NQP to the shoulder periods shown above, the following additional change in consumer surplus arises when the retiming of flights to the shoulder periods requires displacement of existing flights during the shoulder periods.

Business	$\frac{1}{2}(1+t)\sum(pax_d + pax_r)(-\Delta U_{fare})$
Leisure	$\frac{1}{2}\sum(pax_d + pax_r)(-\Delta U_{fare})$
where	
t	average level of indirect taxation in the economy
pax_d , pax_r	number of (business or leisure) passengers travelling in the shoulder periods under the unconstrained scenario (d) and the number of these passengers continuing to travel in the shoulder periods under the night flights policy scenario (r) for the flight grouping (as appropriate) (by ticket type)[30].
ΔU_{fare}	shadow fare for existing (business or leisure) shoulder period passengers continuing to travel in the shoulder periods under the night flights policy scenario (r) for the fight grouping (as appropriate)

[30] In the spreadsheet models, the above formula is applied to calculate the impacts for the whole of the shoulder demand and then a factor is applied to ensure that the impacts only related to the proportion of passengers displaced are calculated.

Change in consumer surplus when there is a reduction in flights in the NQP and there is the potential for the relocation of flights to another UK airport

Business	$$\frac{1}{2}(1+t)\sum(pax_u + pax_s)(-\Delta C_s^*)$$
Leisure	$$\frac{1}{2}\sum(pax_u + pax_s)(-\Delta C_s^*)$$
where	
t	average level of indirect taxation in the economy
pax_u , pax_s	number of (business or leisure) passengers travelling in the NQP under the unconstrained scenario (u) and the night flights policy scenario (s) for the flight grouping (as appropriate) (by ticket type)
ΔC_s^*	The composite (logsum) costs of the shadow fare under the night flights policy scenario (s) and the surface access time penalty for the flight grouping: $$\frac{1}{\beta_{fare}} Ln\left[\left(e^{\beta_{access}\Delta U_{access}}\right) * (1 - p_s) + \left(e^{\beta_{fare}\Delta U_{fare}}\right) * p_s\right]$$ Using the parameters defined above for the passenger choice formulation and p_s is the proportion of passengers continuing to travel in the NQP of those continuing to travel in the NQP and those passengers continuing to travel on flights relocated to another UK airport i.e. ps = pax_s / (pax_s + pax_{uk}) where pax_{uk} is the number of passengers continuing to travel on flights relocated to another UK airport.
ΔU_{fare}	shadow fare for (business or leisure) passengers travelling in the NQP in the night flights policy scenario (s) for the fight grouping (as appropriate)

Change in consumer surplus when there is a reduction in flights in the NQP and there is the potential for the relocation of flights via non-UK airports

Business	$\frac{1}{2}(1+t)\sum(pax_u + pax_s)(-\Delta C_s^*)$
Leisure	$\frac{1}{2}\sum(pax_u + pax_s)(-\Delta C_s^*)$
where	
t	average level of indirect taxation in the economy
pax_u , pax_s	number of (business or leisure) passengers travelling in the NQP under the unconstrained scenario (u) and the night flights policy scenario (s) for the flight grouping (as appropriate) (by ticket type)
ΔC_s^*	The composite (logsum) costs of the shadow fare under the night flights policy scenario (s) and the transfer time penalty for the flight grouping: $$\frac{1}{\beta_{fare}} Ln\left[\left(e^{\beta_{transfer}\Delta U_{transfer}}\right) * (1-p_s) + \left(e^{\beta_{fare}\Delta U_{fare}}\right) * p_s\right]$$ Using the parameters defined above for the passenger choice formulation and p_s is the proportion of passengers continuing to travel in the NQP of those continuing to travel in the NQP and those passengers continuing to travel via a non-UK airport i.e. $p_s = pax_s / (pax_s + pax_{nuk})$ where p_{nuk} is the number of passengers continuing to travel via a non-UK airport.
ΔU_{fare}	shadow fare for (business or leisure) passengers travelling in the NQP in the night flights policy scenario (s) for the fight grouping (as appropriate)

Airlines

4.4.11 For **airlines**, the models estimate the change in the total contribution for airlines under the night flights policy scenario compared to the unconstrained scenario.

4.4.12 The total contribution for each flight grouping in each year under the unconstrained scenario or a night flights policy scenario is estimated using the following equation:

Airline Operating Margin = (R_P + R_C) – C_O

where

R_P = Revenue from Passengers (including ancillary revenue)
R_C = Revenue from Cargo

C_O = Direct Operating Costs of the Flight

4.4.13 Depending on the commercial response that is selected, this can be estimated separately for flights in the NQP, flights rescheduled to the shoulder periods, existing flights that are displaced from the shoulder periods, flights re-scheduled to another UK Airport, and flights accommodating demand that is re-routed via a non-UK airport.

4.4.14 The Direct Operating costs here include components (to allow for cost trends to be independently varied) for:

- Fixed costs[31]: capital and leasing costs plus some elements of maintenance
- Fuel
- Airport charges
- Other: the direct variable element of costs for maintenance, crew and passenger service

4.4.15 Some information for the airline central overhead costs was obtained through the data collection from RDC. However when reviewed by SYSTRA and Northpoint it was agreed that there is likely to be considerable variability in the accounting rules applied by different airlines to allocate these costs to difference flights and thus it would be best to exclude these costs from the measure of contribution from each flight group. This approach ensures that these assumptions do not distort the differences in airline contribution between the test and Baseline scenarios.

4.4.16 The above formulation can be used to calculate the margin for different kinds of airline operations. For passenger flights where belly cargo is also carried the formulation would be as shown above. For passenger flights where **no** belly cargo is carried the formulation would show the revenue from cargo as zero. Conversely, for freighter flights the revenue from passengers would be zero.

4.4.17 In the models, the total contribution for airlines under a policy scenario is estimated under the assumption prices remain the same as in the unconstrained scenario. The benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand in either the NQP or shoulder periods under the policy scenario are estimated separately (see Other Producer Benefits below).

4.4.18 For flights in the NQP, the total airline costs and revenues for each flight grouping in a given year in the modelling period under both the night flights policy scenario and the unconstrained scenario are based on the average airline costs and revenues per flight for flights in the NQP in the base year that fall within the flight grouping (or closely matching flight groupings); and whether any change in the value of the average revenues and costs per flight in real terms is assumed. When calculating the ticket revenue for airlines in future years, the models also ensure that the forecast demand is met in full and not impacted by any changes in the provision of capacity by aircraft size type or flight grouping.

4.4.19 For flights rescheduled to the shoulder periods, flights re-scheduled to another UK Airport, and flights accommodating demand that is re-routed via a non-UK airport, it is assumed that the average airline costs and revenues per flight in a given flight grouping remain the same as for flights in the NQP.

4.4.20 For existing flights that are displaced from the shoulder periods, the total airline costs and revenues for each flight grouping in a given year in the modelling period under both the night flights policy scenario and the unconstrained scenario are based on the average airline costs and revenues per flight for flights in the shoulder periods in the base year that fall within the

[31] As discussed with the Peer Reviewer the treatment of the fixed costs assumes aircraft not operating in the NQP can be re-deployed.

flight grouping (or closely matching flight groupings); and whether any change in the value of the average revenues and costs per flight in real terms is assumed.

Airports

4.4.21 For **airports**, the models estimate the change in the total contribution for airports under the night flights policy scenario compared to the unconstrained scenario.

4.4.22 The total contribution for each flight grouping in each year under the unconstrained scenario or a night flights policy scenario is estimated using the following formula:

Airport Operating Margin $= (R_{LC} + R_{TC} + R_{SP}) - C_O$

Where

R_{LC} = Revenue from Landing Fees (levied on the airlines)
R_{TC} = Other Airport Charges (levied on airlines)
R_{SP} = Passenger Spending at the Airport
C_O = Operating Costs

4.4.23 Depending on the commercial response that is selected, this can be estimated separately for flights in the NQP, flights rescheduled to the shoulder periods, existing flights that are displaced from the shoulder periods, flights re-scheduled to another UK Airport, and flights accommodating demand that is re-routed via a non-UK airport.

4.4.24 For airports, based on the stakeholder engagement, the proportion of fixed costs is not expected to vary significantly between scenarios and therefore omitted from consideration in the calculations.

4.4.25 In the models, the total contribution for airports under a policy scenario is estimated under the assumption prices remain the same as in the unconstrained scenario. The benefits that could accrue to airlines and/or airports from any additional fares required to obtain the constrained level of demand in either the NQP or shoulder periods under the policy scenario are estimated separately (see Other Producer Benefits below).

4.4.26 For flights in the NQP, the total airport costs and revenues for each flight grouping in a given year in the modelling period under both the night flights policy scenario and the unconstrained scenario are based on the average airport costs and revenues per flight for flights in the NQP in the base year that fall within the flight grouping (or closely matching flight groupings); and whether any change in the value of the average revenues and costs per flight in real terms is assumed.

4.4.27 For flights rescheduled to the shoulder periods, flights re-scheduled to another UK Airport, and flights accommodating demand that is re-routed via a non-UK airport, it is assumed that the average airport costs and revenues per flight in a given flight grouping remain the same as for flights in the NQP.

4.4.28 For existing flights that are displaced from the shoulder periods, the total airport costs and revenues for each flight grouping in a given year in the modelling period under both the night flights policy scenario and the unconstrained scenario are based on the average airport costs and revenues per flight for flights in the shoulder periods in the base year that fall within the flight grouping (or closely matching flight groupings); and whether any change in the value of the average revenues and costs per flight in real terms is assumed.

Other Producer Benefits

4.4.29 The approach to the estimation of the shadow fare will deliver a benefit to a combination of airlines and airports as producers who would benefit, in economic theory terms, from being able to realise a premium equivalent to the shadow fare. These producer benefits are estimated by the model, but there is no basis for attributing them to either airlines or airports since the increased price for the scarce resource of travel in the original time period could be applied, and thus realised, by either airports or airlines.

4.4.30 These producer benefits are referred to as "other producer benefits" in this report to distinguish them from the airlines and airports impacts described above. In the models, these other producer benefits are calculated separately for each flight grouping.

4.4.31 Where it is assumed that there is a reduction in flights in the NQP only and that no alternatives are available, the other producer benefits arising from the shadow fare required to constrain demand in the NQP under the night flights policy scenario are calculated using the following formula for each flight group; a single formula is used but this calculation is disaggregated for each ticket type.

Airlines and Airports	$\sum(\mathbf{1}+\boldsymbol{t})(\boldsymbol{\Delta U_{fare}} * \ \boldsymbol{pax_s})$
where	
t	average level of indirect taxation in the economy
pax_s	number of passengers travelling in the NQP under the night flights policy scenario (s) for the flight grouping (by ticket type)
$\boldsymbol{\Delta U_{fare}}$	shadow fare for passengers travelling in the NQP in the night flights policy scenario (s) for the fight grouping (by ticket type)

4.4.21 Where there is the potential for the retiming of flights to the shoulder periods, the relocation of flights to another UK airport or the relocation of flights via non-UK airport, the other producer benefits are calculated using a simplified approach which involves multiplying the change in consumer surplus estimated for these scenarios by the ratio of the other producer benefits to the change in consumer surplus for the scenario where there is a reduction in flights in the NQP only and no alternatives are available shown above (i.e. the other producer benefits for the scenario = the change in consumer surplus for the scenario * the other producer benefits where there is a reduction in flights in the NQP only and no alternatives are available / the change in consumer surplus where there is a reduction in flights in the NQP only and no alternatives are available).

4.4.32 Furthermore, where there is the potential for the retiming of flights to the shoulder periods but this requires the displacement of other flight(s) during the shoulder periods, the other producer benefits arising from the shadow fare required to constrain demand in the shoulder periods under the night flights policy scenario are calculated separately using the following formula for each flight group; a single formula is used but this calculation is disaggregated for each ticket type.

Airlines and Airports	$\sum(\mathbf{1}+\boldsymbol{t})(\boldsymbol{\Delta U_{fare}} * \ \boldsymbol{pax_r})$
Where	
t	average level of indirect taxation in the economy
pax_r	the number of existing shoulder period passengers that continue to travel in the shoulder periods under the night flights policy scenario (r) (by ticket type)[32]
$\boldsymbol{\Delta U_{fare}}$	shadow fare for existing shoulder period passengers continuing to travel in the shoulder periods under the night flights policy scenario (r) for the fight grouping (by ticket type)

Public Accounts

4.4.33 For **public accounts**, the methodology set out in Section 3.5 of DfT WebTAG Unit A5.2 "Aviation Appraisal"[33] has been be adopted with some minor modification.

4.4.34 Where it is assumed that there is a reduction in flights in the NQP only and no alternatives are available, the change in taxation receipts under the night flights policy scenario compared to the unconstrained scenario is calculated using the following formulas for each flight group; these are combined into a single formula in the models and partially disaggregated by ticket type.

Business	$(\mathbf{1}+\boldsymbol{t})\sum(\boldsymbol{tax_s pax_s} - \boldsymbol{tax_u pax_u})$
Leisure	$(\mathbf{1}+\boldsymbol{t})\sum(\boldsymbol{tax_s pax_s} - \boldsymbol{tax_u pax_u}) - \boldsymbol{t}\sum\left[\left(\boldsymbol{tax_s}+\boldsymbol{\Delta U_{fare}}\right)\boldsymbol{pax_s} - \boldsymbol{tax_u pax_u}\right] * (\boldsymbol{UK}\%)$
Where	
t	average level of indirect taxation in the economy

32 In the spreadsheet models, the above formula is applied to calculate the impacts for the whole of the shoulder demand and then a factor is applied to ensure that the impacts only related to the proportion of passengers displaced are calculated.

33 https://www.gov.uk/government/publications/webtag-tag-unit-a5-2-aviation-appraisal-december-2015

pax_u , pax_s	number of (business or leisure) passengers travelling in the NQP under the unconstrained scenario (u) and the night flights policy scenario (s) for the flight grouping (as appropriate) (partially by ticket type)
$\boldsymbol{\Delta U_{fare}}$	shadow fare for leisure passengers travelling in the NQP in the night flights policy scenario (s) for the fight grouping
tax_u, tax_s	tax per passenger under the unconstrained scenario (u) and the night flights policy scenario (s) for the flight grouping (this includes both APD and VAT)
UK%	Proportion UK Leisure Passengers for the flight grouping

4.4.22 Where it is assumed that there is the potential for the retiming of flights to the shoulder periods, the relocation of flights to another UK airport or the relocation of flights via non-UK airport, the change in taxation receipts under the night flights policy scenario compared to the unconstrained scenario is calculated using a simplified approach. This approach involves multiplying the change in consumer surplus estimated for these scenarios by the ratio of the change in taxation receipts to the change in consumer surplus for the scenario where there is a reduction in flights in the NQP only and no alternatives are available shown above (i.e. the change in taxation receipts for the scenario = the change in consumer surplus for the scenario * the change in taxation receipts where there is a reduction in flights in the NQP only and no alternatives are available / the change in consumer surplus where there is a reduction in flights in the NQP only and no alternatives are available).

4.4.35 Furthermore, where there is the potential for the retiming of flights to the shoulder periods but this requires the displacement of existing flights during the shoulder periods, the change in taxation receipts under the night flights policy scenario compared to the unconstrained scenario for existing flights during the shoulder periods are calculated separately using the following formulas for each flight group; again, these are combined into a single formula in the models and partially disaggregated by ticket type.

Business	$\boldsymbol{(1+t)\sum(tax_r pax_r - tax_d pax_d)}$
Leisure	$\boldsymbol{(1+t)\sum(tax_r pax_r - tax_d pax_d) - t\sum\left[\left(tax_r + \Delta U_{fare}\right)pax_r - tax_d pax_d\right] * (UK\%)}$
Where	
t	average level of indirect taxation in the economy
pax_d, pax_r	number of (business or leisure) passengers travelling in the shoulder periods under the unconstrained scenario (d) and the number of these passengers continuing to

	travel in the shoulder periods under the night flights policy scenario (r) for the flight grouping (as appropriate) (partially by ticket type)[34]
ΔU_{fare}	shadow fare for existing leisure shoulder period passengers continuing to travel in the shoulder periods under the night flights policy scenario (r) for the fight grouping
tax_d, tax_r	tax per passenger travelling in the shoulder periods under the unconstrained scenario (d) and passenger continuing to travel in the shoulder periods under the night flights policy scenario (r) for the flight grouping (this includes both APD and VAT)
UK%	Proportion UK Leisure Passengers for the flight grouping

4.4.36 For flights in the NQP, the total APD and VAT for each flight grouping in a given year in the modelling period under both the night flights policy scenario and the unconstrained scenario are based on the average APD and VAT per flight for flights in the NQP in the base year that fall within the flight grouping (or closely matching flight groupings); and whether any change in the value of the average APD and VAT per flight in real terms is assumed.

4.4.37 For flights rescheduled to the shoulder periods, flights re-scheduled to another UK Airport, and flights accommodating demand that is re-routed via a non-UK airport, it is assumed that the average APD and VAT per flight in a given flight grouping remain the same as for flights in the NQP.

4.4.38 For existing flights that are displaced from the shoulder periods, the total APD and VAT for each flight grouping in a given year in the modelling period under both the night flights policy scenario and the unconstrained scenario are based on the average APD and VAT per flight for flights in the shoulder periods in the base year that fall within the flight grouping (or closely matching flight groupings); and whether any change in the value of the average APD and VAT per flight in real terms is assumed.

4.5 Input Parameters

4.5.1 The models have been designed with the in-built flexibility to allow the user to vary the rules by which the analysis is undertaken.

Assumptions for the policy scenario

4.5.2 The models allow the following variables to be varied for each season in each year of the modelling period.

- The movement limit for the season;
- The noise quota limit for the season;
- The proportion of the movement limit and/or noise quota limit that is allowed to be "carried over" to the next season;

[34] In the spreadsheet models, the above formula is applied to calculate the impacts for the whole of the shoulder demand and then a factor is applied to ensure that the impacts only related to the proportion of passengers displaced are calculated.

- The proportion of the movement limit and/or noise quota limit that is allowed to be "overrun" in the current season at the cost of an equal deduction from the corresponding allocation in the next season;
- The size of the additional penalty for a level of "overrun" of the movement limit and/or noise quota limit in the current season by more than this amount;
- The absolute maximum "overrun" of the movement limit and/or noise quota limit that is allowed in the current season; and
- The maximum QC allowed for flights in the season.

4.5.3 In addition, the models allow the user to vary whether movements by QC/0 aircraft count towards the movement limits in each year of the modelling period, and model the movement and noise quota limits as annual limits instead of season limits.

4.5.4 Furthermore, the models allow the user to determine the movements and noise quota allowed under the night flights regime off-model and overwrite the above inputs by entering this information into the models manually.

Other Input Parameters

4.5.5 The models allow the following other input parameters and assumptions to be varied by the model user.

- The number of non-commercial flights in each season split between arrivals and departures, the percentage of these are QC/0 and the average QC for those that aren't;
- The present value base year (default of 2016/17);
- The discount factor used for the Present Value estimates (default of 3.5%);
- The parameters used to estimate the impacts on passenger demand;
- The values of time used in the model, split by business and leisure;
- The proportion of passengers travelling for business by carrier type;
- The proportion of passengers that are transfer passengers by carrier type;
- The proportion of leisure passengers that are assumed to be UK residents by carrier type ('Proportion UK Leisure Passengers');
- The average additional surface access travel time for passengers who switch to travelling via another UK airport;
- The average additional transfer time for passengers who switch to travelling via a non-UK airport;
- The proportion of transfer legs for passengers who switch to travelling via a non-UK airport that fall in each route length category, split by the original route length category;
- The flight displacement time for passengers who travel on flights which are retimed from the NQP to the shoulder periods ('Displacement of travel time to the shoulder periods'), split by the original time band category; and
- The growth in each airline and airport cost and revenue, the public accounts revenues, value of times and GDP per person in real terms in each year of the modelling period.

4.5.6 The models also allow users to replace the base year input data for the NQP and shoulder periods, the future fleet mix assumptions and the future growth assumptions if required.

5. ILLUSTRATIVE MODEL RESULTS AND FINDINGS

5.1 Introduction

5.1.1 This Chapter provides illustrative results for a range of test scenarios. These test scenarios have only been used to test that the models are producing plausible outcomes and to demonstrate the capability of the models. In other words, the scenarios presented in this section do not represent scenarios that are being considered by the Government in its review of the night flights regime.

5.1.2 The models initially estimate an unconstrained scenario for each airport, which is intended to represent what would happen in the absence of any night flight restrictions at the airport. The models then use this unconstrained scenario as the basis for estimating the economic impacts of the night flight restrictions that are specified for a given scenario. Two scenarios can then be compared to estimate the economic impacts of any changes in the night flight restrictions that are specified between the scenarios.

5.1.3 In this section, the following codes are used to refer to each of the airports: LHR is Heathrow; LGW is Gatwick; and STN is Stansted.

5.2 Assumptions

5.2.1 The illustrative results for all of the scenarios presented in this report (including the Unconstrained Scenario and the Baseline Scenario) have been estimated on the basis of the assumptions listed in Table 5.1 where relevant. The rationale for each assumption is explained below.

Table 5.1: Assumptions Used

ASSUMPTION	VALUE	RATIONALE
Unconstrained Growth in Flights	The assumptions about the growth in the number of night flights in the NQP at each airport match those in the DfT's consultation-stage impact assessment on the next night flights regime[35]. This assumes that the number of night flights in the NQP would grow over time in line with forecasts provided to the DfT by Gatwick and Stansted in the absence of any night flight restrictions; and assumes that there would be no growth in the NQP in future years at Heathrow. However, it should be noted that there is significant uncertainty around what the future growth of night flights in the NQP would be in the absence of any restrictions in future years.	Assumptions provided by DfT
Future Fleet Mix	The assumptions about the future fleet mix used for night flights in the NQP at each airport match those in the DfT's consultation-stage impact assessment on the next night flights regime. However, again, it should be noted that these assumptions are subject to uncertainty.	Assumptions provided by DfT

[35] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/582867/night-flights-impact-assessment.pdf

ASSUMPTION	VALUE	RATIONALE
Non-Commercial Flights in 2014/15	Based on DfT analysis undertaken for the DfT's consultation-stage impact assessment on the next night flights regime, the number of non-commercial flights during the NQP, the percentage of these that are QC/0 ('% Zero QC') and the average QC for those that have a non-aero value ('Avg non-zero QC') at each airport in 2014/15 are assumed to be as follows[36]. (See tables below)	Assumptions provided by DfT
Non-Commercial Flights in other years	It is assumed that the number of non-commercial flights during the NQP, the percentage of these that are QC/0 and the average QC for those that are non-zero remain constant over time and therefore remain the same as in 2014/15.	Simplifying assumption
Treatment of QC/0 aircraft	It is assumed that movements by QC/0 aircraft would not count towards the movement and noise quota limits.	Current Government policy

Gatwick

	Number of movements	% Zero QC	Avg non-zero QC
Winter - Arrivals	40	85%	0.42
Summer - Arrivals	22	91%	0.25
Winter - Departures	14	71%	0.38
Summer - Departures	17	94%	2.00

Heathrow

	Number of movements	% Zero QC	Avg non-zero QC
Winter - Arrivals	7	100%	
Summer - Arrivals	11	100%	
Winter - Departures	4	50%	0.50
Summer - Departures	2	50%	0.25

Stansted

	Number of movements	% Zero QC	Avg non-zero QC
Winter - Arrivals	183	69%	0.47
Summer - Arrivals	224	59%	0.36
Winter - Departures	120	52%	0.52
Summer - Departures	158	60%	0.69

[36] A very small number of additional flights were treated as "non-commercial" flights for the purposes of the study based on SYSTRA's judgement. Such flights are not taken into account in these figures.

<table>
<tr><th>ASSUMPTION</th><th>VALUE</th><th>RATIONALE</th></tr>
<tr><td>Carryovers and Overruns</td><td>It is assumed that carryovers and overruns are not used, so their values are set to zero.</td><td>Simplifying assumption</td></tr>
<tr><td>Maximum QC of aircraft</td><td>4 (except for test scenario R8)</td><td>Current Government policy</td></tr>
<tr><td>Airline Response to Constraints</td><td>Where it is necessary to reduce the number of movements in the NQP to meet the constraints of the policy scenario, it is assumed that a pro-rata reduction is applied to all flight groups. It is also assumed that there are no changes in the fleet mix and consequently that the switch to quieter aircraft option is not used.</td><td>Simplifying assumption</td></tr>
<tr><td>Flight displacement time for passengers who travel on flights which are retimed from the NQP to the shoulder periods (hours)</td><td>
<table>
<tr><th>Existing Time Period</th><th>Displacement from night slot (hrs)</th></tr>
<tr><td>00:00:00 - 00:59:59</td><td>1.0</td></tr>
<tr><td>01:00:00 - 01:59:59</td><td>2.0</td></tr>
<tr><td>02:00:00 - 02:59:59</td><td>3.0</td></tr>
<tr><td>03:00:00 - 03:59:59</td><td>3.0</td></tr>
<tr><td>04:00:00 - 04:59:59</td><td>2.0</td></tr>
<tr><td>05:00:00 - 05:59:59</td><td>1.0</td></tr>
<tr><td>23:30:00 - 23:59:59</td><td>0.5</td></tr>
</table>
</td><td>SYSTRA assumption for the purpose of model illustration based on an average displacement time</td></tr>
<tr><td>Additional transfer time for passengers who switch to travelling via a non-UK airport (average)</td><td>90 minutes</td><td>SYSTRA assumption for the purpose of model illustration based on typical flight connecting times</td></tr>
<tr><td>The length of the transfer leg into the UK airport for passengers who switch to travelling via a non-UK airport</td><td>
<table>
<tr><th></th><th colspan="5">Route Length on transfer leg (hours)</th></tr>
<tr><th>Original Route Length</th><th>< 3</th><th>3 - 6</th><th>6 - 9</th><th>6 - 9</th><th>12+</th></tr>
<tr><td>< 3 hours</td><td>100%</td><td>0%</td><td>0%</td><td>0%</td><td>0%</td></tr>
<tr><td>3 - 6 hours</td><td>80%</td><td>20%</td><td>0%</td><td>0%</td><td>0%</td></tr>
<tr><td>6 - 9 hours</td><td>60%</td><td>20%</td><td>20%</td><td>0%</td><td>0%</td></tr>
<tr><td>9 - 12 hours</td><td>40%</td><td>20%</td><td>20%</td><td>20%</td><td>0%</td></tr>
<tr><td>12+ hours</td><td>20%</td><td>20%</td><td>20%</td><td>20%</td><td>20%</td></tr>
</table>
</td><td>SYSTRA assumption for the purpose of model illustration based on expert judgement</td></tr>
<tr><td>Additional surface access travel time for passengers who switch to</td><td>60 minutes</td><td>SYSTRA assumption for the purpose of model</td></tr>
</table>

<table>
<tr><th>ASSUMPTION</th><th>VALUE</th><th>RATIONALE</th></tr>
<tr><td>travelling via another UK airport (average)</td><td></td><td>illustration based on expert judgement</td></tr>
<tr><td>Proportion of passengers travelling for business</td><td>Based on DfT analysis of CAA data for all passengers using these airports in 2014, it is assumed that the proportion of passengers travelling for business by carrier type is as follows:
<table>
<tr><th></th><th>Charter</th><th>Full-Service</th><th>Low-Cost</th><th>Freight</th></tr>
<tr><td>LGW</td><td>1%</td><td>14%</td><td>17%</td><td>N/A</td></tr>
<tr><td>LHR</td><td>5%</td><td>30%</td><td>*</td><td>N/A</td></tr>
<tr><td>STN</td><td>1%</td><td>35%</td><td>15%</td><td>N/A</td></tr>
</table>
* According to the DfT analysis, there were no low-cost flights at LHR in 2014.

For the purposes of this analysis, SYSTRA has assumed that the percentage for low-cost flights at LHR is the same as the percentage for full-service flights at LHR.</td><td>Assumptions provided by DfT / SYSTRA assumption for the purpose of model illustration based on expert judgement</td></tr>
<tr><td>Proportion of leisure passengers that are UK residents</td><td>Based on DfT analysis of CAA data for all passengers using these airports in 2014, it is assumed that the proportion of leisure passengers that are UK residents by carrier type is as follows:
<table>
<tr><th></th><th>Charter</th><th>Full-Service</th><th>Low-Cost</th><th>Freight</th></tr>
<tr><td>LGW</td><td>98%</td><td>71%</td><td>70%</td><td>N/A</td></tr>
<tr><td>LHR</td><td>63%</td><td>40%</td><td>*</td><td>N/A</td></tr>
<tr><td>STN</td><td>99%</td><td>57%</td><td>58%</td><td>N/A</td></tr>
</table>
* According to the DfT analysis, there were no low-cost flights at LHR in 2014.

For the purposes of this analysis, SYSTRA has assumed that the percentage for low-cost flights at LHR is the same as the percentage for full-service flights at LHR.</td><td>Assumptions provided by DfT / SYSTRA assumption for the purpose of model illustration based on expert judgement</td></tr>
<tr><td>Proportion of passengers that are transfer passengers</td><td>
<table>
<tr><th></th><th>Charter</th><th>Full-Service</th><th>Low-Cost</th><th>Freight</th></tr>
<tr><td>All airports</td><td>0%</td><td>20%</td><td>0%</td><td>0%</td></tr>
</table></td><td>SYSTRA assumption based on expert judgment</td></tr>
<tr><td>Airport and airline costs and revenues</td><td>It is assumed that airport and airlines costs and revenues per movement in each flight group used in the analysis would remain constant in real terms during the modelling period (except for the adjustment applied to ticket revenue to airlines that is described in Paragraph 4.4.18).</td><td>Simplifying assumption</td></tr>
<tr><td>Government impacts</td><td>It is assumed that APD and VAT receipts per movement in each flight group used in the analysis would remain constant in real terms during the modelling period.</td><td>Simplifying assumption</td></tr>
</table>

ASSUMPTION	VALUE	RATIONALE
Values of Time	The values of time assumed in this analysis are taken from WebTAG: TAG data book, July 2016[37] and are assumed to grow in real terms over time in line with the growth in real GDP per person assumed in the TAG data book.	Assumptions provided by DfT
Passenger willingness to pay	It is assumed that the passenger willingness to pay associated with the model parameters used to calculate the shadow fare would change over time in line with the changes in real GDP per person assumed in the TAG data book.	SYSTRA assumption for the purpose of model illustration based on expert judgement
Average level of indirect taxation in the economy	The average level of indirect taxation in the economy has been assumed to be 19% in line with the TAG data book.	Assumption provided by DfT

5.3 Results for the Unconstrained Scenario

5.3.1 The unconstrained scenario is intended to represent what would happen in the absence of any night flight restrictions at these airports. This section presents the results for this scenario on the basis of the assumptions listed in Table 5.1 where relevant.

5.3.2 The total number of movements during the NQP estimated for each of the three airports during the entire 10 year modelling period (2017/18 to 2026/27) under the unconstrained scenario is shown in Table 5.2. This includes the number of non-commercial flights that is assumed in each year.

Table 5.2: Total Operations during the NQP under the Unconstrained Scenario (10 years from 2017/18 to 2026/27)

LHR	LGW	STN
55,030	168,664	148,940

5.3.3 Figures 3_I to 3_III show the estimated change in the total number of movements during the NQP, the total QC and the average QC per operation for each airport under the unconstrained scenario. These figures do reflect the non-commercial flights that are assumed in each year.

5.3.4 The total number of movements during the NQP at LGW and STN are estimated to show steady growth through the modelling period, while LHR is estimated to remain flat at around 5,500 annual operations.

5.3.5 The Quota Count (QC) trends shown in Figure 3_II follow a broadly similar pattern to the movements although this is partially offset by assumed changes in the fleet mix (i.e. a move towards quieter aircraft resulting in a lower average QC per operation). Hence, as shown in

[37] https://www.gov.uk/government/publications/webtag-tag-data-book-july-2016

Figure 3_III, LHR and STN show a falling trend in QC/operation, although LGW - which has the strongest assumed growth in movement - is flat in terms of QC/operation.

5.3.6 Figure 3_IV summarises the estimated change in total number of passengers travelling during the NQP. Passenger demand at LHR is flat through the period, while that at STN shows modest growth from around 1.2m in 2017/18 to around 1.5m in 2026/27. Stronger growth is estimated at LGW, from around 2.4m in 2017/18 to around 3.2m in 2026/27.

5.3.7 Figure 3_V summarises the estimated airline contribution – that is, the difference between airline revenues and airline costs – at the three airports. Again, LGW is estimated to show the strongest growth – from around £175m in 2016/17 to around £233m in 2026/27. The airline contribution at LHR is flat throughout the period at around £130m, while STN shows a declining trend – from around £22m to around £13m. This arises from a combination of the assumed changes in fleet mix and the assumption of no real changes in unit costs and revenues. In this scenario the overall cost increase per flight is 0.3 percentage points per annum higher than the change in revenue per flight. The compound impact of this assumption results in the 2026/27 contribution per flight being half that in 2017/18 (note that this contribution is calculated by comparing the large total revenue and cost, and so appears sensitive to small changes in the underlying assumptions).

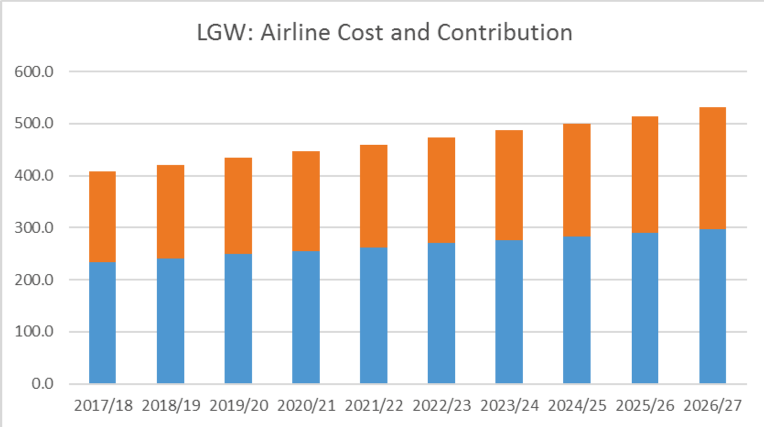
5.3.8 Figure 3_VI summarises the estimated change in government income – that is, the sum of revenue from Air Passenger Duty (APD) and VAT on passenger expenditure at the airport in this case – at the three airports. Estimated Government income at LGW and STN shows a rising trend through the assessment period in the range £7m to £9m. Government income at LHR is significantly lower than at the other two airports; this is due to lower revenue collection from APD since the majority of night quota passengers are arrivals where no APD is levied.

5.3.9 Figure 4 compares and contrasts the total airline costs and the total airline contribution in the NQP at the three airports under the unconstrained scenario. The sum of the total airline costs and the total airline contribution is equal to the total airline revenues.

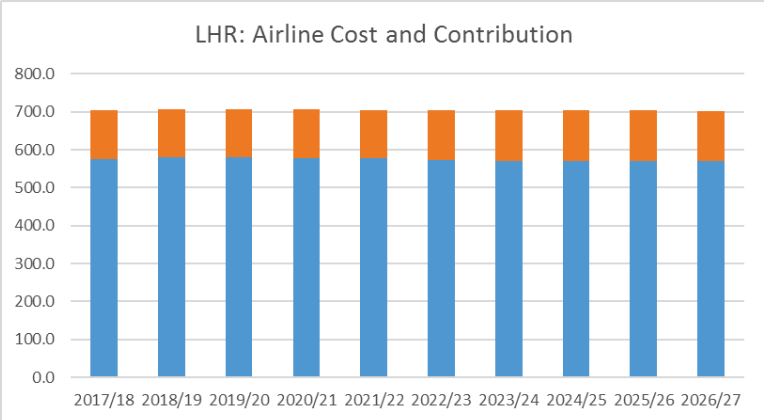
Figure 3: Trends under the Unconstrained Scenario

Figure 4: Comparison of Airline Costs and Contribution for flights in the NQP under the unconstrained scenario

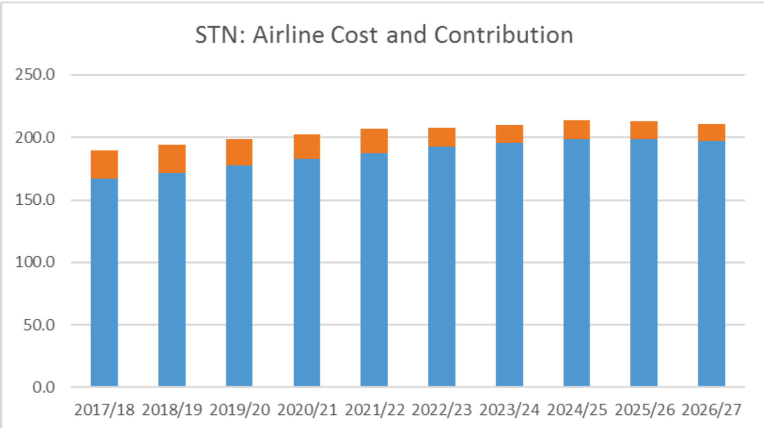
The airline contribution at Gatwick is sizeable in proportion to airline costs and results from the mix of traffic and the revenues and costs expected from these flights in the NQP.



Airline costs are significantly higher at Heathrow reflecting the higher costs associated with operating long-haul full service flights. Both costs and contribution are estimated to remain constant over time, consistent with the underlying assumption of no growth employed in the unconstrained scenario.



Airline costs are markedly lower at Stansted reflecting the low cost short haul nature of the majority of its operations. The forecast number and mix of aircraft operations results in a flattening of the contribution towards the end of the modelled period. One reason for the difference in results between Gatwick and Stansted appears to be due to there being a higher proportion of cargo operations at Stansted which offer lower unit airline revenues compared to passenger flights.



5.3.10 Table 5.3 compares the key characteristics of the movements in the NQP at each airport during the 10 year modelling period (2017/18 to 2026/27) under the unconstrained scenario. This table does not reflect the non-commercial flights that are assumed in each year.

5.3.11 Night flight operations at LHR are dominated by full-service carriers, with the vast majority of operations (94%) also being arriving flights. A wide spread of route lengths occur with the highest share (39%) being long haul flights of 9 – 12 hours in length. Aircraft size types are correspondingly towards the upper end of the scale, with the largest share (51%) being 251 –

350 seat aircraft. There is a reasonably even distribution of QC aircraft types with the majority being either QC 0.5 or 1.0. The seasonal split of flights is roughly evenly balanced between summer and winter.

5.3.12 LGW has a more even distribution of carrier types, with the largest group being low-cost carriers (47%). The majority of these are arriving flights (88%). Route lengths at LGW tend to be short or medium haul – 6 hours or less, and aircraft types are correspondingly smaller than those found at LHR being predominantly 151 – 250 seat aircraft. LGW's operations as a whole tend to be quieter than those at LHR, with the largest category being QC 0.25. LGW's operations display a distinct seasonal pattern, with 88% occurring in the summer season.

5.3.13 STN has a majority of low-cost carrier types (48%) and it is also the only one of the three airports that has a significant proportion of freight only flights (38%). The majority of flights are arriving (71%), but the share of these is lower than at the other two airports. Route lengths are predominantly short haul (78%) ie 3 hours or less, with aircraft types at the lower end of the size scale; 151 – 250 passengers or 71 – 150 passengers. The aircraft fleet at STN has the largest share of QC 0.5 aircraft (52%) and also the largest share of QC 2.0 or above aircraft (11%). STN also displays a seasonal bias towards summer flights (67%), but not to the same degree as LGW.

Table 5.3: Summary of the key characters of movements in the NQP under the unconstrained scenario[38]

DIMENSION	TOTAL OPERATIONS OVER 10-YR PERIOD			%		
	LHR	LGW	STN	LHR	LGW	STN
Total Operations	**54,790**	**167,734**	**142,090**			
Carrier Type[39]						
Charter	20	37,381	11,660	0%	22%	8%
Full-Service	54,690	51,139	7,942	100%	30%	6%
Low-Cost	0	79,214	68,813	0%	47%	48%
Freighter	80	0	53,675	0%	0%	38%
Route Length						
< 3 hours	3,062	87,933	111,215	6%	52%	78%
3 - 6 hours	11,541	70,878	22,742	21%	42%	16%
6 - 9 hours	6,875	7,976	6,432	13%	5%	5%
9 - 12 hours	21,102	946	1,309	39%	1%	1%
12+ hours	12,209	-	393	22%	0%	0%

[38] This table does not reflect the non-commercial flights that are assumed in each year.
[39] DfT provided assumptions over the allocation of carrier types.

	LHR	LGW	STN	LHR	LGW	STN
Size Type						
0-70	60	249	6,539	0%	0%	5%
71-150	600	10,531	28,898	1%	6%	20%
151-250	12,620	143,150	91,119	23%	85%	64%
251-350	27,870	12,989	5,677	51%	8%	4%
351-500	13,540	802	9,857	25%	0%	7%
501+	100	13	0	0%	0%	0%
QC						
0	1,309	3,398	8,481	2%	2%	6%
0.25	11,256	84,138	23,032	21%	50%	16%
0.5	23,583	61,915	73,505	43%	37%	52%
1	16,202	17,142	21,901	30%	10%	15%
2+	2,439	1,141	15,172	4%	1%	11%
Direction						
Arrival	51,770	147,991	100,860	94%	88%	71%
Departure	3,020	19,743	41,230	6%	12%	29%
Season						
Winter	26,780	19,861	47,287	49%	12%	33%
Summer	28,010	147,873	94,803	51%	88%	67%

5.3.14 Table 5.4 compares the total economic contribution to the airports and airlines at each of the airports over the 10 year modelling period (2017/18 to 2026/27) under the unconstrained scenario; all values are undiscounted. The key observations from these comparisons are as follows:

- The largest number of movements in the NPQ is estimated to be at Gatwick with the least at Heathrow.
- The total **QC** is estimated to be highest at Stansted; 35% higher than Gatwick and from 12% fewer flights.
- **Airline** costs and revenues are estimated to be highest at Heathrow. It is estimated that the total contribution for airlines from flights at Gatwick would be higher, although the contribution per passenger and movement is lower than at Heathrow. The total airline contribution estimated at Stansted is relatively low.
- **Airport** costs and revenues are estimated to be highest at Gatwick, although the total contribution at Stansted is estimated to be the largest. The contribution to Heathrow airport profitability is similar to that at Gatwick..

- Overall the **total economic contribution** to the airports and airlines is estimated to sum to between around £0.3bn and around £2.0bn over the 10 year period at each airport and around £3.6bn across all three.

The total movements and QC shown in Table 5.4 reflect the non-commercial flights that are assumed in each year.

Table 5.4: Total economic contribution to the airports and airlines over the 10 year modelling period under the unconstrained scenario (undiscounted)[40]

	Airlines					Passengers	Airport			Overall
Unconstrained Scenario	Operations	QC	Cost (£m)	Revenue (£m)	Total Contribution (£m)	Total Demand	Cost (£m)	Revenue (£m)	Total Contribution (£m)	Total Contribution (£m)
Gatwick	168,664	71,480	**2,656**	**4,674**	**2,018**	**27,550,300**	**247**	**267**	**20**	**2,037**
Heathrow	55,030	35,827	**5,750**	**7,044**	**1,294**	**13,412,073**	**207**	**229**	**22**	**1,316**
Stansted	148,940	96,700	**1,870**	**2,048**	**178**	**13,527,264**	**102**	**172**	**70**	**248**

[40] The costs, revenues and total contribution from non-commercial flights are not reflected in the estimates presented in this table as these could not be modelled.

5.4 Results for Baseline Scenario

5.4.1 The Baseline Scenario is a scenario where it is assumed that the movement and noise quota limits under the current night flight regime remain unchanged during the 10 year modelling period (2017/18 to 2026/27).

5.4.2 This section presents the results for the following scenarios on the basis of the assumptions listed in Table 5.1 where relevant:

- Unconstrained scenario (used as benchmark for assessing the Baseline scenario)
- Baseline scenario under the following commercial responses:
  - Reduction in flights in the NQP only - Pro-rata reduction applied to all flight groups ('Flights Lost/Passengers no longer travel')
  - Re-scheduling of flights from the NQP to the shoulder periods, without requiring the displacement of shoulder period flights ('Flights re-timed to Shoulder periods')
  - Re-scheduling of flights from the NQP to the shoulder periods, requiring the displacement of shoulder period flights ('Re-timing to Shoulder periods with displacement')
  - The potential for demand to re-route to another UK airport, requiring a longer surface access leg ('Passengers take flights to other UK Airports')
  - The potential for demand to re-route to a non-UK airport, requiring a transfer to take another flight into the constrained airport ('Passengers take flights via other non-UK hub')

Total movements and QC under the Baseline scenario

5.4.3 To put the results for the Baseline Scenario into context, Figures 5 to 7 show the total movements in the NQP and the total QC at each airport under the Baseline Scenario and show the same results for the Unconstrained Scenario.

5.4.4 The results for the Baseline Scenario presented in this section relate to the 'Reduction in flights in the NQP only - Pro-rata reduction applied to all flight groups' ('Flights Lost/Passengers no longer travel') commercial response only.

5.4.5 In each of these figures:

- The movement or noise quota limit for each season without any carry-overs and over-runs is shown as a line on the chart; this is labelled as the "Limit". Since carryovers and overruns are not used for the purposes of the test scenarios, these are the movement and noise quota limits that apply under this scenario.
- The total movements in the NQP or the total QC estimated under the Unconstrained Scenario are shown as a (red) solid column; this is labelled as "Unconstrained Scenario".
- The total movements in the NQP or the total QC estimated under the Baseline Scenario are shown as a (orange) solid column; this is labelled as "Baseline Scenario".

5.4.6 It should be noted that the total movements shown in these figures include movements by QC/0 aircraft which do not count towards the movement and noise quota limits under the test scenarios. These figures also reflect the non-commercial movements that are assumed in each year.

5.4.7 For **Gatwick** the key observation from Figure 5 is that the constraints under the Baseline Scenario will act to significantly reduce the total number of movements in the NQP during the 10 year modelling period (2017/18 to 2026/27) in comparison to the Unconstrained Scenario.

This suggests the night flights regime will result in significant economic impacts at Gatwick under the Baseline Scenario in comparison to the Unconstrained Scenario.

Figure 5: Movements by Season and QC in the NPQ at Gatwick under the Baseline Scenario[41]

[41] Zero QC movements are not constrained by the limit, so the estimated Baseline Scenario movements may exceed the limit.

5.4.8 For **Heathrow**, the key observation from Figure 6 is that it is estimated that the Baseline scenario leads to a minimal impact on the number of movements in the NQP. This is due to the simplifying assumption that carry-overs and over-runs are not used under the test scenarios which results in a small constraint on the number of movements in the winter season. This suggests the night flights regime will result in very small economic impacts at Heathrow under the Baseline scenario.

Figure 6: Movements by Season and QC in the NPQ at Heathrow under the Baseline Scenario[42]

[42] Zero QC movements are not constrained by the limit, so the estimated Baseline Scenario movements may exceed the limit.

5.4.9 For **Stansted** the key observation from Figure 7 is that the constraints under the Baseline Scenario will act to significantly reduce the total number of movements in the NQP during the 10 year modelling period (2017/18 to 2026/27) in comparison to the Unconstrained Scenario. This suggests the night flights regime will result in significant economic impacts at Stansted under the Baseline Scenario in comparison to the Unconstrained Scenario.

Figure 7: Movements by Season and QC in the NPQ at Stansted under the Baseline Scenario[43]

[43] Zero QC movements are not constrained by the limit, so the estimated Baseline Scenario movements may exceed the limit.

Economic Impacts under the Baseline Scenario relative to the Unconstrained Scenario

5.4.10 Tables 5.5 to 5.6 present estimates of the economic impacts of the night flights regime under the Baseline Scenario on airports, airlines, passengers and the Government over the 10 year modelling period (2017/18 to 2026/27) on the basis of the assumptions listed in Table 5.1 where relevant; all figures shown are undiscounted. These estimates represent the economic impact on the affected parties compared to the Unconstrained Scenario. As such, the estimates illustrate the economic impacts of any constraints for these airports if the current night flights restrictions were maintained in comparison to a scenario where there are no restrictions on night flights in the future under these assumptions (including the simplifying assumption that carryovers and overruns are not used). It should be noted that, under the options where flights are re-timed to the shoulder periods or demand is re-rerouted to other airports, the estimates in the tables reflect the impacts of this as well as the impacts in relation to night flights in the NQP. These tables also show the total economic estimates estimated under the unconstrained scenario for comparison purposes.

5.4.11 The following observations can be made for Gatwick and Stansted:

- The largest estimated economic impacts are generally the dis-benefits to passengers. This results from the shadow fare which is computed for each flight group to represent the effective price required to constrain demand to the level required by the policy scenario. In addition, depending on the commercial response, further dis-benefits arise from the change in flight time where flights are re-timed, and additional travel time where passengers switch to using another airport.
- If flights removed from the NQP can be **re-timed to the shoulder periods,** then a limited proportion of flights are estimated to be lost overall due to a proportion of passenger demand being supressed and the assumption that freight only flights are not re-timed.
- If re-timing flights removed from the NQP to the shoulder periods requires existing flights to be **displaced from operating in the shoulder periods,** then this results in the largest estimated economic dis-benefits to passengers.
- For the option where there is the potential for demand to re-route through other **UK airports**, fewer passengers are suppressed compared to the option where there is the potential for demand to re-route to **non UK airports**. This is largely due to the assumptions regarding the relative magnitude of the time penalty for transferring at a non-UK hub compared to additional surface access travel time for using another UK airport, and the impact of this on the number of passengers that choose to do this or for whom it is assumed that the option is available (full service passengers only). The total passenger dis-benefit is correspondingly larger for re-routing through non-UK airports compared to the option to use other UK airports.
- Over 10 years, the estimated overall total economic impacts resulting from a continuation of the existing policy at **Gatwick** range from -£143m to -£543m; this is labelled as the "Total Impacts". Holding prices constant, the impact on the total contribution for airlines is estimated to range from -£36m to -£400m, and the impact on the total contribution for airports is estimated to be up to -£23m. There is, however, estimated to be the potential for producer benefits of between £683m and £891m to arise to a combination of the airlines and the airport due to the additional fares estimated to be required to obtain the constrained level of demand; this is shown separately and is labelled as the "Other Producer Benefits". It is estimated that Public accounts could be impacted by between -£60m and -£80m. The dis-benefit to passengers are estimated to range from £726m to £961m over the 10 year period.
- Over 10 years, the estimated overall total economic impacts resulting from a continuation of the existing policy at **Stansted** range from -£72m to -£121m. Holding prices constant, the airline impacts are estimated to range from -£11m to -£56m, and the airport impacts are estimated to range from -£3m to -£19m. Again, there is, however, estimated to be the potential for producer benefits of between £250m and £350m to arise to a combination

of the airlines and airport due to the additional fares estimated to be required to obtain the constrained level of demand. It is estimated that Public accounts could be impacted by between -£31m and -£43m. The dis-benefits to passengers are estimated to range from £266m to £370m over the 10 year period.

- The Baseline Scenario at **Heathrow** is estimated to result in minimal impacts. As noted above, this is due to the simplifying assumption that carryovers and overruns are not used under the test scenarios which results in there being a small constraint on movements in the winter season.

The total movements and QC shown in these tables do reflect the non-commercial flights that are assumed in each year.

Table 5.5: Economic impacts at Gatwick over the 10 year modelling period (2017/18 to 2026/27) under Baseline Scenario compared to the Unconstrained Scenario (undiscounted)[44]

	Airlines					Passengers		Producer	Airport			Public Accounts		Overall
Impacts relative to the Unconstrained scenario from response variants (10 year assessment period, undiscounted)	Operations (number of movements)	Quota Count Usage	Costs (£m)	Revenues (£m)	Total Airline Contribution (£m)	Total Demand (million passengers)	Total Passenger (dis)Benefit (£m)	Other Producer Benefits (£m)	Costs (£m)	Revenues (£m)	Total Airport Contribution (£m)	Tax Impact (£m)	Total Contribution (£m)	Total Impacts (£m)
Unconstrained Situation	168,664	71,480	**2,656**	**4,674**	**2,018**	**27.6**	**0**	**0**	**247**	**267**	**20**	0	**0**	**2,037**
Flights Lost/Passengers no longer travel	-33,364	-14,271	**-488**	**-888**	**-400**	**-5.5**	**-787**	**739**	**-49**	**-56**	**-7**	-65	**-65**	**-519**
Flights re-timed to Shoulder periods	-2,779	-14,271	**-41**	**-77**	**-36**	**-0.5**	**-763**	**716**	**-4**	**-4**	**0**	-60	**-60**	**-143**
Re-timing to Shoulder periods with displacement	-33,364	-14,271	**-538**	**-907**	**-370**	**-5.3**	**-961**	**891**	**-47**	**-71**	**-23**	-80	**-80**	**-543**
Passengers take flights to other UK Airports	-20,921	-14,271	**-307**	**-555**	**-248**	**-3.4**	**-726**	**683**	**-31**	**-35**	**-4**	-60	**-60**	**-355**
Passengers take flights via other non-UK hub	-32,447	-14,271	**-470**	**-865**	**-395**	**-5.3**	**-781**	**734**	**-48**	**-54**	**-7**	-65	**-65**	**-513**
Percentage Impacts														
Flights Lost/Passengers no longer travel	-20%	-20%	-18%	-19%	-20%	-20%			-20%	-21%	-34%			**-25%**
Flights re-timed to Shoulder periods	-2%	-20%	-2%	-2%	-2%	-2%			-2%	-2%	-1%			**-7%**
Re-timing to Shoulder periods with displacement	-20%	-20%	-20%	-19%	-18%	-19%			-19%	-26%	-118%			**-27%**
Passengers take flights to other UK Airports	-12%	-20%	-12%	-12%	-12%	-12%			-12%	-13%	-21%			**-17%**
Passengers take flights via other non-UK hub	-19%	-20%	-18%	-19%	-20%	-19%			-19%	-20%	-34%			**-25%**

[44] The economic impacts relating to non-commercial flights are not reflected in the estimates of the economic impacts presented in this table as these could not be modelled.

Table 5.6: Economic impacts at Stansted over the 10 year modelling period (2017/18 to 2026/27) under Baseline Scenario compared to the Unconstrained Scenario (undiscounted)[45]

	Airlines					Passengers		Producer	Airport			Public Accounts		Overall
Impacts relative to the Unconstrained scenario from response variants (10 year assessment period, undiscounted)	Operations (number of movements)	Quota Count Usage	Costs (£m)	Revenues (£m)	Total Airline Contribution (£m)	Total Demand (million passengers)	Total Passenger (dis)Benefit (£m)	Other Producer Benefits (£m)	Costs (£m)	Revenues (£m)	Total Airport Contribution (£m)	Tax Impact (£m)	Total Contribution (£m)	Total Impacts (£m)
Unconstrained Situation	148,940	96,700	**1,870**	**2,048**	**178**	**13.5**	**0**	**0**	**102**	**172**	**70**	0	**0**	**248**
Flights Lost/Passengers no longer travel	-26,430	-18,140	**-359**	**-414**	**-55**	**-2.8**	**-335**	**318**	**-21**	**-35**	**-14**	-36	**-36**	**-121**
Flights re-timed to Shoulder periods	-8,011	-18,140	**-146**	**-162**	**-15**	**-0.2**	**-321**	**304**	**-1**	**-4**	**-3**	-36	**-36**	**-72**
Re-timing to Shoulder periods with displacement	-26,430	-18,140	**-313**	**-324**	**-11**	**-2.1**	**-370**	**350**	**-15**	**-34**	**-19**	-43	**-43**	**-92**
Passengers take flights to other UK Airports	-16,888	-18,140	**-153**	**-178**	**-25**	**-1.7**	**-266**	**250**	**-13**	**-22**	**-9**	-31	**-31**	**-80**
Passengers take flights via other non-UK hub	-26,220	-18,140	**-356**	**-413**	**-56**	**-2.7**	**-320**	**304**	**-21**	**-34**	**-14**	-35	**-35**	**-121**
Percentage Impacts														
Flights Lost/Passengers no longer travel	-18%	-19%	-19%	-20%	-31%	-20%			-20%	-20%	-20%			**-49%**
Flights re-timed to Shoulder periods	-5%	-19%	-8%	-8%	-9%	-1%			-1%	-3%	-4%			**-29%**
Re-timing to Shoulder periods with displacement	-18%	-19%	-17%	-16%	-6%	-15%			-15%	-20%	-27%			**-37%**
Passengers take flights to other UK Airports	-11%	-19%	-8%	-9%	-14%	-13%			-13%	-13%	-12%			**-32%**
Passengers take flights via other non-UK hub	-18%	-19%	-19%	-20%	-32%	-20%			-20%	-20%	-19%			**-49%**

[45] The economic impacts relating to non-commercial flights are not reflected in the estimates of the economic impacts presented in this table as these could not be modelled.

5.5 Results for Other Test Scenarios

5.5.1 A range of other test scenarios have been used to test that the models are producing plausible outcomes and to demonstrate the capability of the models. However, it should be noted that these scenarios do not represent scenarios that are being considered by the Government in its review of the night flights regime.

5.5.2 **Appendix C** describes all of the test scenarios that have been run and **Appendix F** includes summary results for all of these scenarios.

5.5.3 The results for several of the test scenarios on the basis of the assumptions listed in Table 5.1 where relevant are briefly discussed below. The comparisons made below are relative to the Baseline Scenario. All figures refer to the total over the 10 year modelling period (2017/18 to 2026/27) and are undiscounted.

Gatwick - Test L1: 50% increase in movement limit [Table 5.7]

- This test represents an increase in the permitted aircraft movements. Consequently, compared to the Baseline Scenario, this scenario is estimated to deliver **benefits overall** of between around £89m and £318m.
- Holding prices constant, airports and airlines contributions would increase; however, these increases are estimated to be offset by a reduction in the theoretical producer benefits which derive from the lower fares estimated to be required to obtain the constrained level of demand under the L1 Scenario compared to the Baseline.
- The higher level of activity is estimated to give rise to a positive contribution to **public accounts** of between around £28m and £44m.

Heathrow – Test R5: 30% reduction in movement and noise quota limits [Table 5.8]

- This test results in a reduction in the number of movements that are permitted in the NQP at Heathrow.
- Given the overall constraints on operations within the shoulder periods, it is not likely that significant numbers of additional flights could be accommodated within the existing schedule outside of the NQP, thus the higher impact response scenarios have a higher outcome likelihood.
- Compared to the Baseline Scenario, this scenario is estimated to result in overall total dis-benefits of between around -£277m and -£580m.
- Holding prices constant, the **airline** impacts estimated range from reduced contributions of between around -£33m to -£296m, and **Airport** dis-benefits are estimated to be up to -£5m (excluding the 'Flights re-timed to shoulder periods' scenario where the airport contribution is estimated to rise).
- However, it is estimated that these could be offset by the potential for **other producer benefits** to increase by between around £1341m and £1531m that could arise to a combination of the airlines and the airport due to the potential to charge higher fares for the constrained flights.
- **Passenger dis-benefits** are estimated at between around £1567m and £1787m.
- It is estimated that **Public Accounts** could be impacted by up to around -£22m.

Stansted – Test L1: 50% Increase in movement limit [Table 5.9]

- The principal constraint in this scenario is the QC limit which is also the binding constraint in the Baseline scenario so allowing for an increase in aircraft movements has only a minimal impact and the **passenger, airline** and **airport and public accounts** impacts are broadly neutral.

5.5.4 Using the default model parameters, the impact on passengers at Gatwick and Stansted is largest where changes in the night flight regime would result in changes in unconstrained flights being `displaced to the shoulder periods but that these flights <u>cannot</u> be accommodated without losing existing flights in the shoulder periods, since there is both the impact of not flying in the NQP and the loss of shoulder period travellers. The pattern is slightly different for Heathrow as the modelling results in a slightly larger overall dis-benefit where passengers can no longer travel at all compared to when there is displacement of flights in the shoulder periods.

5.5.5 The total movements and QC shown in these tables do reflect the non-commercial flights that are assumed in each year.

Table 5.7: Economic impacts at Gatwick over the 10 year modelling period (2017/18 to 2026/27) – Test L1: 50% increase in movement limits (Undiscounted)[46]

	Airlines					Passengers		Producer	Airport			Public Accounts		Overall
Impacts relative to the Baseline scenario from response variants (10 year assessment period, undiscounted)	Operations (number of movements)	Quota Count Usage	Costs (£m)	Revenues (£m)	Total Airline Contribution (£m)	Total Demand (million passengers)	Total Passenger (dis)Benefit (£m)	Other Producer Benefits (£m)	Costs (£m)	Revenues (£m)	Total Airport Contribution (£m)	Tax Impact (£m)	Total Contribution (£m)	Total Impacts (£m)
Baseline														
Flights Lost/Passengers no longer travel	135,300	57,209	**2,168**	**3,786**	**1,617**	**22.1**	**-787**	**739**	**198**	**211**	**13**	-65	**-65**	**1,518**
Flights re-timed to Shoulder periods	165,885	57,209	**2,615**	**4,597**	**1,982**	**27.1**	**-763**	**716**	**243**	**262**	**20**	-60	**-60**	**1,894**
Re-timing to Shoulder periods with displacement	135,300	57,209	**2,119**	**3,767**	**1,648**	**22.3**	**-961**	**891**	**200**	**196**	**-4**	-80	**-80**	**1,494**
Passengers take flights to other UK Airports	147,743	57,209	**2,350**	**4,119**	**1,770**	**24.1**	**-726**	**683**	**216**	**232**	**16**	-60	**-60**	**1,683**
Passengers take flights via other non-UK hub	136,217	57,209	**2,186**	**3,809**	**1,623**	**22.2**	**-781**	**734**	**199**	**212**	**13**	-65	**-65**	**1,524**
Test Scenario														
Flights Lost/Passengers no longer travel	153,222	64,882	**2,431**	**4,263**	**1,833**	**25.0**	**-611**	**606**	**224**	**241**	**17**	-32	**-32**	**1,813**
Flights re-timed to Shoulder periods	167,379	64,882	**2,637**	**4,639**	**2,001**	**27.3**	**-626**	**621**	**245**	**265**	**20**	-32	**-32**	**1,983**
Re-timing to Shoulder periods with displacement	153,222	64,882	**2,408**	**4,254**	**1,847**	**25.1**	**-694**	**687**	**225**	**234**	**9**	-37	**-37**	**1,812**
Passengers take flights to other UK Airports	158,980	64,882	**2,514**	**4,418**	**1,903**	**26.0**	**-595**	**590**	**233**	**250**	**18**	-31	**-31**	**1,885**
Passengers take flights via other non-UK hub	153,647	64,882	**2,439**	**4,274**	**1,835**	**25.1**	**-609**	**604**	**225**	**241**	**17**	-32	**-32**	**1,815**
Absolute Impacts														
Flights Lost/Passengers no longer travel	17,922	7,673	**262**	**477**	**215**	**2.9**	**176**	**-134**	**26**	**30**	**4**	33	**33**	**294**
Flights re-timed to Shoulder periods	1,494	7,673	**22**	**41**	**19**	**0.2**	**137**	**-95**	**2**	**2**	**0**	28	**28**	**89**
Re-timing to Shoulder periods with displacement	17,922	7,673	**289**	**487**	**199**	**2.8**	**267**	**-204**	**25**	**38**	**13**	44	**44**	**318**
Passengers take flights to other UK Airports	11,237	7,673	**165**	**298**	**133**	**1.8**	**131**	**-93**	**17**	**19**	**2**	28	**28**	**203**
Passengers take flights via other non-UK hub	17,430	7,673	**253**	**465**	**212**	**2.9**	**172**	**-130**	**26**	**29**	**4**	33	**33**	**291**
Percentage Impacts														
Flights Lost/Passengers no longer travel	13%	13%	**12%**	**13%**	**13%**	**13%**			**13%**	**14%**	**28%**			**19%**
Flights re-timed to Shoulder periods	1%	13%	**1%**	**1%**	**1%**	**1%**			**1%**	**1%**	**1%**			**5%**
Re-timing to Shoulder periods with displacement	13%	13%	**14%**	**13%**	**12%**	**13%**			**13%**	**19%**	**-355%**			**21%**
Passengers take flights to other UK Airports	8%	13%	**7%**	**7%**	**8%**	**8%**			**8%**	**8%**	**14%**			**12%**
Passengers take flights via other non-UK hub	13%	13%	**12%**	**12%**	**13%**	**13%**			**13%**	**14%**	**27%**			**19%**

[46] The economic impacts relating to non-commercial flights are not reflected in the estimates of the economic impacts presented in this table as these could not be modelled.

Table 5.8:: Economic impacts at Heathrow over the 10 year modelling period (2017/18 to 2026/27) – Test R5: 30% reduction in movement and noise quota limits (Undiscounted)[47]

	Airlines					Passengers		Producer	Airport			Public Accounts		Overall
Impacts relative to the Baseline scenario from response variants (10 year assessment period, undiscounted)	Operations (number of movements)	Quota Count Usage	Costs (£m)	Revenues (£m)	Total Airline Contribution (£m)	Total Demand (million passengers)	Total Passenger (dis)Benefit (£m)	Other Producer Benefits (£m)	Costs (£m)	Revenues (£m)	Total Airport Contribution (£m)	Tax Impact (£m)	Total Contribution (£m)	Total Impacts (£m)
Baseline														
Flights Lost/Passengers no longer travel	54,171	35,240	**5,656**	**6,930**	**1,273**	**13.2**	**-199**	**197**	**204**	**226**	**22**	-2	**-2**	**1,293**
Flights re-timed to Shoulder periods	54,937	35,240	**5,739**	**7,031**	**1,292**	**13.4**	**-211**	**209**	**207**	**229**	**22**	-2	**-2**	**1,311**
Re-timing to Shoulder periods with displacement	54,171	35,240	**5,696**	**6,978**	**1,282**	**13.2**	**-212**	**210**	**204**	**227**	**22**	-2	**-2**	**1,301**
Passengers take flights to other UK Airports	54,441	35,240	**5,686**	**6,966**	**1,280**	**13.3**	**-197**	**196**	**205**	**227**	**22**	-2	**-2**	**1,299**
Passengers take flights via other non-UK hub	54,290	35,240	**5,664**	**6,937**	**1,274**	**13.2**	**-198**	**197**	**204**	**226**	**22**	-2	**-2**	**1,293**
Test Scenario														
Flights Lost/Passengers no longer travel	41,909	27,020	**4,335**	**5,312**	**977**	**10.1**	**-1,986**	**1,728**	**156**	**174**	**17**	-24	**-24**	**712**
Flights re-timed to Shoulder periods	53,656	27,020	**5,597**	**6,856**	**1,259**	**13.1**	**-1,777**	**1,550**	**202**	**225**	**24**	-21	**-21**	**1,034**
Re-timing to Shoulder periods with displacement	41,909	27,020	**4,932**	**6,036**	**1,104**	**10.9**	**-1,913**	**1,682**	**168**	**188**	**20**	-23	**-23**	**870**
Passengers take flights to other UK Airports	46,036	27,020	**4,781**	**5,858**	**1,077**	**11.2**	**-1,798**	**1,568**	**172**	**192**	**20**	-22	**-22**	**845**
Passengers take flights via other non-UK hub	43,806	27,020	**4,446**	**5,425**	**979**	**10.5**	**-1,919**	**1,671**	**162**	**180**	**19**	-23	**-23**	**727**
Absolute Impacts														
Flights Lost/Passengers no longer travel	-12,262	-8,220	**-1,321**	**-1,618**	**-296**	**-3.1**	**-1,787**	**1,531**	**-47**	**-52**	**-5**	-22	**-22**	**-580**
Flights re-timed to Shoulder periods	-1,281	-8,220	**-142**	**-175**	**-33**	**-0.3**	**-1,567**	**1,341**	**-5**	**-4**	**1**	-20	**-20**	**-277**
Re-timing to Shoulder periods with displacement	-12,262	-8,220	**-764**	**-942**	**-178**	**-2.4**	**-1,702**	**1,471**	**-37**	**-39**	**-2**	-21	**-21**	**-431**
Passengers take flights to other UK Airports	-8,405	-8,220	**-905**	**-1,108**	**-203**	**-2.1**	**-1,601**	**1,372**	**-32**	**-35**	**-3**	-20	**-20**	**-455**
Passengers take flights via other non-UK hub	-10,483	-8,220	**-1,218**	**-1,512**	**-294**	**-2.7**	**-1,721**	**1,474**	**-42**	**-46**	**-3**	-22	**-22**	**-566**
Percentage Impacts														
Flights Lost/Passengers no longer travel	-23%	-23%	**-23%**	**-23%**	**-23%**	**-23%**			**-23%**	**-23%**	**-21%**			**-45%**
Flights re-timed to Shoulder periods	-2%	-23%	**-2%**	**-2%**	**-3%**	**-2%**			**-2%**	**-2%**	**5%**			**-21%**
Re-timing to Shoulder periods with displacement	-23%	-23%	**-13%**	**-13%**	**-14%**	**-18%**			**-18%**	**-17%**	**-10%**			**-33%**
Passengers take flights to other UK Airports	-15%	-23%	**-16%**	**-16%**	**-16%**	**-16%**			**-16%**	**-15%**	**-11%**			**-35%**
Passengers take flights via other non-UK hub	-19%	-23%	**-22%**	**-22%**	**-23%**	**-21%**			**-21%**	**-20%**	**-15%**			**-44%**

[47] The economic impacts relating to non-commercial flights are not reflected in the estimates of the economic impacts presented in this table as these could not be modelled.

Table 5.9: Economic impacts at Stansted over the 10 year modelling period (2017/18 to 2026/27) – Test L1: 50% increase in movement limits (Undiscounted) [48]

	Airlines					Passengers		Producer	Airport			Public Accounts		Overall
Impacts relative to the Baseline scenario from response variants (10 year assessment period, undiscounted)	Operations (number of movements)	Quota Count Usage	Costs (£m)	Revenues (£m)	Total Airline Contribution (£m)	Total Demand (million passengers)	Total Passenger (dis)Benefit (£m)	Other Producer Benefits (£m)	Costs (£m)	Revenues (£m)	Total Airport Contribution (£m)	Tax Impact (£m)	Total Contribution (£m)	Total Impacts (£m)
Baseline														
Flights Lost/Passengers no longer travel	122,510	78,561	**1,511**	**1,634**	**122**	**10.8**	**-335**	**318**	**81**	**137**	**57**	-36	**-36**	**127**
Flights re-timed to Shoulder periods	140,929	78,561	**1,723**	**1,886**	**162**	**13.4**	**-321**	**304**	**100**	**167**	**67**	-36	**-36**	**176**
Re-timing to Shoulder periods with displacement	122,510	78,561	**1,557**	**1,724**	**166**	**11.5**	**-370**	**350**	**86**	**138**	**52**	-43	**-43**	**156**
Passengers take flights to other UK Airports	132,052	78,561	**1,717**	**1,869**	**152**	**11.8**	**-266**	**250**	**89**	**150**	**62**	-31	**-31**	**168**
Passengers take flights via other non-UK hub	122,721	78,561	**1,513**	**1,635**	**121**	**10.8**	**-320**	**304**	**81**	**138**	**57**	-35	**-35**	**127**
Test Scenario														
Flights Lost/Passengers no longer travel	124,089	79,600	**1,532**	**1,658**	**126**	**10.9**	**-324**	**311**	**82**	**139**	**57**	-34	**-34**	**137**
Flights re-timed to Shoulder periods	141,367	79,600	**1,731**	**1,895**	**163**	**13.4**	**-316**	**302**	**100**	**168**	**67**	-35	**-35**	**182**
Re-timing to Shoulder periods with displacement	124,089	79,600	**1,575**	**1,743**	**168**	**11.6**	**-359**	**344**	**87**	**140**	**53**	-40	**-40**	**165**
Passengers take flights to other UK Airports	133,058	79,600	**1,727**	**1,880**	**154**	**11.9**	**-259**	**247**	**89**	**151**	**62**	-29	**-29**	**174**
Passengers take flights via other non-UK hub	124,288	79,600	**1,534**	**1,659**	**125**	**10.9**	**-310**	**297**	**82**	**140**	**57**	-33	**-33**	**137**
Absolute Impacts														
Flights Lost/Passengers no longer travel	1,579	1,039	**21**	**24**	**3**	**0.2**	**11**	**-7**	**1**	**2**	**1**	2	**2**	**10**
Flights re-timed to Shoulder periods	438	1,039	**8**	**9**	**1**	**0.0**	**5**	**-2**	**0**	**0**	**0**	2	**2**	**6**
Re-timing to Shoulder periods with displacement	1,579	1,039	**18**	**19**	**1**	**0.1**	**11**	**-6**	**1**	**2**	**1**	2	**2**	**9**
Passengers take flights to other UK Airports	1,006	1,039	**10**	**11**	**1**	**0.1**	**7**	**-3**	**1**	**1**	**1**	1	**1**	**7**
Passengers take flights via other non-UK hub	1,567	1,039	**21**	**24**	**3**	**0.2**	**10**	**-7**	**1**	**2**	**1**	2	**2**	**10**
Percentage Impacts														
Flights Lost/Passengers no longer travel	1%	1%	**1%**	**1%**	**3%**	**2%**			**2%**	**2%**	**1%**			**8%**
Flights re-timed to Shoulder periods	0%	1%	**0%**	**0%**	**1%**	**0%**			**0%**	**0%**	**0%**			**3%**
Re-timing to Shoulder periods with displacement	1%	1%	**1%**	**1%**	**1%**	**1%**			**1%**	**2%**	**2%**			**6%**
Passengers take flights to other UK Airports	1%	1%	**1%**	**1%**	**1%**	**1%**			**1%**	**1%**	**1%**			**4%**
Passengers take flights via other non-UK hub	1%	1%	**1%**	**1%**	**3%**	**2%**			**2%**	**1%**	**1%**			**8%**

[48] The economic impacts relating to non-commercial flights are not reflected in the estimates of the economic impacts presented in this table as these could not be modelled.

5.6 Sensitivity Test

5.6.1 The estimation of the passenger dis-benefits, other producer benefits and the public accounts impacts, and the estimation of the outputs for the passenger responses are sensitive to the modelling approach adopted, including choice of the parameters extracted from the DfT NAPAM model. The results reported earlier show that the passenger dis-benefits that are estimated where the night flight regime presents a constraint compared to the Unconstrained scenario. To illustrate the impact of choosing alternative parameters, a sensitivity test has been undertaken with the default NAPAM choice parameters reduced in sensitivity by factoring by 0.8; this is an arbitrary choice and used purely as a sensitivity test. This factoring implies that the assumptions regarding the time penalties for travelling at different times, to different UK airports or via non-UK hubs have a smaller impact, but that a larger shadow fare would be required to price off passengers in response to a constraint on operations. The impact on the choice model parameters assumed for this test is as follows:

PARAMETER	DEFAULT BUSINESS VALUE	DEFAULT LEISURE VALUE	TEST BUSINESS VALUE	TEST LEISURE VALUE
Surface Access Cost (β_{access})	-0.0303	-0.134	-0.02424	-0.1072
Air Fare (β_{fare})	-0.000449	-0.0151	-0.0003592	-0.01208
Cost of (Direct) Wait Time (βwait)	-0.09	-0.103	-0.072	-0.0824
Cost of Transfer Time ($\beta_{transfer}$)	-0.0503	-0.187	-0.04024	-0.1496
A (Wait Time)	0.2	0.4	0.2	0.4

5.6.2 Table 5.10 presents a comparison between two variants of Heathrow Test R5 (30% reduction to the Baseline movement and noise quota limits) with the default and variant choice sensitivity parameters. It is expected that the relative scale of impacts for Heathrow can readily be inferred for the other airports for scenarios where the unconstrained demand cannot be accommodated.

5.6.3 The comparison of outputs from these tests demonstrates that the choice of sensitivity parameter may have:

- Only small (only up to around 2%) differences in the total monetary impacts and on the numbers of passengers (and aircraft operations) overall.
- Within this there will potentially be a more marked impact on the total passenger dis-benefit calculated, with up to a 7% larger dis-benefit calculated from the 20% reduction in model parameter[49]. The change in the total passenger dis-benefit is calculated to be largest where flights are re-timed to the shoulder periods requiring displacement of other flights from the shoulder periods.

[49] A larger dis-benefit is calculated from smaller magnitude model parameters since the equivalent shadow fare required to suppress the passenger demand needs to be larger since the sensitivity test model effectively assumes that passengers are less sensitive to price.

Table 5.10: Economic impacts at Heathrow over the 10 year modelling period. Impact of reducing the passenger cost sensitivity by 20% on R5 30% reduction in movement and noise quota limits (Undiscounted)[50]

	Airlines					Passengers		Producer	Airport			Public Accounts		Overall
Impacts of the differences between the default sensitivity parameters and the sensitivity parameters reduced by 20% for the R5 scenario (10 year assessment period, undiscounted)	Operations (number of movements)	Quota Count Usage	Costs (£m)	Revenues (£m)	Total Airline Contribution (£m)	Total Demand (million passengers)	Total Passenger (dis)Benefit (£m)	Other Producer Benefits (£m)	Costs (£m)	Revenues (£m)	Total Airport Contribution (£m)	Tax Impact (£m)	Total Contribution (£m)	Total Impacts (£m)
Baseline														
Flights Lost/Passengers no longer travel	41,909	27,020	**4,335**	**5,312**	**977**	**10.1**	**-1,986**	**1,728**	**156**	**174**	**17**	-24	**-24**	**712**
Flights re-timed to Shoulder periods	53,656	27,020	**5,597**	**6,856**	**1,259**	**13.1**	**-1,777**	**1,550**	**202**	**225**	**24**	-21	**-21**	**1,034**
Re-timing to Shoulder periods with displacement	41,909	27,020	**4,932**	**6,036**	**1,104**	**10.9**	**-1,913**	**1,682**	**168**	**188**	**20**	-23	**-23**	**870**
Passengers take flights to other UK Airports	46,036	27,020	**4,781**	**5,858**	**1,077**	**11.2**	**-1,798**	**1,568**	**172**	**192**	**20**	-22	**-22**	**845**
Passengers take flights via other non-UK hub	43,806	27,020	**4,446**	**5,425**	**979**	**10.5**	**-1,919**	**1,671**	**162**	**180**	**19**	-23	**-23**	**727**
Parameters * 0.8														
Flights Lost/Passengers no longer travel	41,909	27,020	**4,335**	**5,312**	**977**	**10.1**	**-2,105**	**1,840**	**156**	**174**	**17**	-27	**-27**	**703**
Flights re-timed to Shoulder periods	53,908	27,020	**5,625**	**6,891**	**1,265**	**13.1**	**-1,870**	**1,638**	**203**	**226**	**24**	-23	**-23**	**1,034**
Re-timing to Shoulder periods with displacement	41,909	27,020	**4,946**	**6,053**	**1,107**	**10.9**	**-2,044**	**1,807**	**168**	**188**	**20**	-25	**-25**	**865**
Passengers take flights to other UK Airports	46,882	27,020	**4,872**	**5,970**	**1,097**	**11.4**	**-1,876**	**1,644**	**176**	**196**	**20**	-24	**-24**	**862**
Passengers take flights via other non-UK hub	44,766	27,020	**4,502**	**5,482**	**980**	**10.6**	**-2,003**	**1,753**	**164**	**184**	**20**	-25	**-25**	**724**
Absolute Impacts														
Flights Lost/Passengers no longer travel	0	0	**0**	**0**	**0**	**0.0**	**-119**	**112**	**0**	**0**	**0**	-3	**-3**	**-10**
Flights re-timed to Shoulder periods	252	0	**28**	**35**	**6**	**0.1**	**-93**	**89**	**1**	**1**	**0**	-2	**-2**	**0**
Re-timing to Shoulder periods with displacement	0	0	**14**	**17**	**3**	**0.0**	**-131**	**125**	**0**	**0**	**0**	-2	**-2**	**-5**
Passengers take flights to other UK Airports	846	0	**91**	**112**	**20**	**0.2**	**-78**	**76**	**3**	**4**	**0**	-2	**-2**	**17**
Passengers take flights via other non-UK hub	959	0	**56**	**57**	**1**	**0.2**	**-84**	**82**	**3**	**3**	**1**	-2	**-2**	**-2**
Percentage Impacts														
Flights Lost/Passengers no longer travel	0%	0%	**0%**	**0%**	**0%**	**0%**	6%	7%	**0%**	**0%**	**0%**	11%	11%	**-1%**
Flights re-timed to Shoulder periods	0%	0%	**1%**	**1%**	**1%**	**0%**	5%	6%	**0%**	**0%**	**0%**	11%	11%	**0%**
Re-timing to Shoulder periods with displacement	0%	0%	**0%**	**0%**	**0%**	**0%**	7%	7%	**0%**	**0%**	**0%**	11%	11%	**-1%**
Passengers take flights to other UK Airports	2%	0%	**2%**	**2%**	**2%**	**2%**	4%	5%	**2%**	**2%**	**2%**	9%	9%	**2%**

[50] The economic impacts relating to non-commercial flights are not reflected in the estimates of the economic impacts presented in this table as these could not be modelled.

Passengers take flights via other non-UK hub	2%	0%	**1%**	**1%**	**0%**	**2%**	4%	5%	**2%**	**2%**	**4%**	10%	10%	**0%**

6. SUMMARY AND CONCLUSIONS

6.1 Summary

6.1.1 This research project has sought to break new ground by attempting to quantify the economic impacts of possible changes to the night flights regime on airports, airlines, passengers and the public accounts. The project has developed a methodological framework and the models to allow investigation and testing of these impacts.

6.1.2 A stakeholder consultation was held to canvas opinions on issues relating to the night flights regime. The feedback from this consultation was used to inform the development of the methodological framework and the models.

6.1.3 These models were developed using the best available data sources given the resource and time constraints of the study, and seek to synthesize the complex range of possible responses by airlines and passengers to potential changes to the night flights regime. However, this is a highly complex topic requiring, by necessity, a series of simplifying assumptions, and these models have a number of other limitations, meaning that the results generated by these models are subject to significant uncertainty.

6.1.4 The models and the input parameters, methodological framework and results have been reviewed both within the project team and by an independent peer reviewer. Both the approach and the results are considered to be reasonable and plausible.

6.2 Conclusions

6.2.1 The models provide a flexible analysis tool which allows the user to estimate the economic impacts of the night flights regime to airports, airlines, passengers and public accounts under a wide range of scenarios.

6.2.2 In comparison to a scenario where there are no restrictions on night flights, the results presented in this report illustrate that the night flights regime could have significant economic impacts on airports, airlines, passengers and public accounts in the modelling period.

6.2.3 However, it should be noted that the results generated by the models are sensitive to the assumptions made, the data sources that have been used and the methodological choices that have been made when developing the models; and are therefore subject to significant uncertainty.

6.2.4 Nevertheless, the authors of this study consider that this project provides a sound starting point for the analysis of economic impacts relating to possible changes in the night flights regime. As indicated by the Peer Reviewer, there are a number of ways in which the models could be further developed at a later date. These would include measures to validate key input parameters as well as streamlining the operation of the models

APPENDIX A: LITERATURE REVIEW OF SIMILAR STUDIES

Relevant References and Recent Studies at London Airports

The current night flights regime at the three London airports extends until the year 2017. In studying any possible changes to the current night flights regime it is useful to understand how the current regime came into being. The background to the consultation and decision can be found in a series of reports published by the DfT. These are briefly summarised below.

In addition to the DfT documents on the night flights regime; night flights at the London airports and the economic value of these flights has been a popular topic for study in recent years. There has been a particular focus on the night flights and associated noise issues at Heathrow. A brief summary review of the most relevant studies is also provided below.

Dept for Transport: Review of the Quota Count (QC) System Used for Administering the Night Noise Quotas at Heathrow, Gatwick and Stansted Airports (2003)

In 2003 both CAA_ERCD and NATS were commissioned to advise DfT on the use of night noise quotas at London's major airports. The main conclusions were:

i. The method by which aircraft QC classifications are determined from official certificated noise levels remains appropriate.

ii. The areas within which noise levels under the approach path exceed those reached under the departure path are close to the airport and relatively small.

iii. The use of operational sound exposure levels in the 1991 analysis (instead of the certificated effective perceived noise levels) distorted the difference between arrivals and departures.

iv. The percentage of noise generated which falls on airport land is greater for take-offs than landings. Adjusting the levels of noise impact to account for this reduces the difference between the community impact of arrivals and departures.

v. The effects of (iii) and (iv) tend to cancel each other out.

vi. Improvements in departure noise achieved by modern aircraft have not been matched by equal noise reductions on approach. This closes the gap by around 2 EPNdB.

vii. As a consequence of factors iii – vi above, the actual difference between the impact of arrivals and departures is now calculated to be equivalent to 9 EPNdB. This is the differential currently used to calculate QC values, but less than the differential of 11 dB measured in the 1991 study.

The Review concluded that although there is potential through modification of the Quota Count system, to increase the incentives for airlines to use quieter aircraft at night, the best place to examine options is through the consultation process on night noise regimes.

Department for Transport: Night Flying Restrictions at Heathrow, Gatwick and Stansted Airports – Impact Assessment (IA No: DFT00232 - 15 July 2014)

This document, which takes the form of a regulatory impact assessment as formally required by Government for any primary or secondary legislation, or decision applying such, was published alongside the 2014 Night Noise regime announcement. Given the relatively minor changes to the regime, it was not considered proportionate to complete a monetised cost benefit analysis.

Department for Transport – Night Flying restrictions at Heathrow, Gatwick and Stansted – Stage 1 Consultation (January 2013) & Stage 2 Consultation (November 2013)

The Stage 1 Consultation aimed to gather evidence on the costs and benefits of possible options for the next night flights regime, seeking views and options that had not been previously considered, both for reducing noise impact and the case for night flights. Approximately 800 responses were received. The consultation considered environmental and noise abatement objectives and how well these have been met by the current regime, including to encourage use of quieter aircraft, avoid overall noise during NQP increasing above 2002-03 levels and to minimise sleep disturbance caused by overflying the noisiest aircraft, seeking views on how these objectives should change. Questions were asked regarding a number of issues, including the time period over which restrictions should apply, amendments to the QC system, length of the next regime, dispensation use and guidelines, operational procedures such as increasing the angle of descent, changes in demand for night flights, the implications of a ban on high QC rated flights during the night period, the possibility of introducing a guaranteed respite period, the use of landing fees or other economic incentives to encourage use of quieter aircraft, noise insulation and compensation schemes for residents and impacts on air passengers.

Many responses to the Stage 1 consultation suggested that the findings of the Airports Commission should be taken into account before changing the night restrictions regime. A three year regime similar to the current regime with some additional minor restrictions was proposed in Stage 2 to provide temporary stability while decisions are made.

Most responses from the public to the Stage 1 consultation argued for a ban on night flights, as did most environmental groups, community groups and local government organisations, although many accepted this might have to be phased and some accepted that a total ban may be unrealistic but still argued for tighter restrictions. Industry stakeholders said that quotas should allow for future demand to be met, rather than being based on historic use. Heathrow said that demand for night slots was not currently being met. Industry respondents argued that tighter restrictions would affect freight and low cost carriers in particular. London Boroughs argued for increased landing charges to encourage use of quieter aircraft at night, as well as additional research into costs of impacts. Most respondents agreed that waiting until the interim or final report of the Airports Commission before making a decision.

The Stage 2 Consultation considered specific proposals for changes to the night flights regime, along with aspects that would not be changed. 1100 responses were received. It was proposed to extend the operational ban of QC/8 and QC/16 aircraft to the entire night period and trial new operational procedures such as increased angle of descent, while the quota count system would stay the same. The consultation took into consideration new and emerging evidence including responses from the Stage 1 consultation, in relation to the adverse health effects of aircraft noise and the benefits of night flights. Trials of early morning respite periods at all three London airports were discussed. These were carried out in 2013, with specific zones avoided by aircraft at the most sensitive time of day. It was concluded that the Heathrow trials brought respite to residents in these zones but some areas saw an increase in night flights and areas between the zones were overflown more during the trial.

"Economic value of night flights" (CEPA, 2015)

CEPA undertook a study on the economic value of flights during the night period at Heathrow Airport.

The first phase of this project updated previous work on the GVA of night flights to the UK economy, including any model refinements that better capture the true GVA of night flights. Alongside this analysis CEPA prepared a report on future economic hotspots for aviation to help guide qualitative research on the importance of night flights for servicing destinations likely to become important.

For the second phase of the project, CEPA undertook a full Cost Benefit Analysis (CBA) of further restricting the night flight regime at Heathrow. This analysis followed the Department for Transport's

(DfT) WebTAG methodology where available, and other leading methodologies for quantifying social impacts such as night time noise. This WebTAG methodology is a detailed implementation of the Green Book, including specified parameters and methods for quantifying certain items for the purpose of transport appraisal. This analysis considered a range of different consumers, for example, the value of travel time varies by income level.

The CBA also quantified the impact for different travellers of changes to travel schedules, and impacts arising from the occupation of potential new runway capacity by former night flights at either Heathrow or Gatwick airports, in the event of these expansions going ahead. Analysis also compared European peers, and the advantages to transfer hubs such as Dubai and Istanbul of stronger Heathrow night restrictions.

Relevant Issues Raised in Consultation Responses to 2013 Night Flights Consultation

The Mayor of London's response to the night flight restrictions at Heathrow, Gatwick and Stansted (2013).

The mayor seeks to protect the health and well-being of Londoners while ensuring London's growth and prosperity. The response highlights the adverse health effects of disrupted sleep and also draws attention to the definition of the night period which does not cover the times when people are wishing to sleep. It also points out the importance of early morning arrivals for long haul routes to the Far East and North America and the role of night flights in air freight and therefore access to global supply chains.

Department for Transport – Night Flying restrictions at Heathrow, Gatwick and Stansted (July 2014)

After consideration of the consultation responses, the government has set the following environmental objectives: to limit and where possible reduce the people significantly affected by aircraft noise at night, to maintain a stable regulatory regime pending decisions on future airport capacity while allowing for growth, and to encourage the use of quieter aircraft during the night quota period. The extension to the current night flights regime was announced, as well as an extension to the ban on rare movements made by older noisier aircraft. Evidence was considered from the Stage 2 consultation that there would be unforeseen increased demand for night flights in Summer at Stansted and Gatwick. However it was uncertain whether the projections would prove correct.

Economic Value of Night Flights at Heathrow (Oxford Economics, 2011)

Research carried out by Oxford Economics in 2011 showed that flights during the NQP at Heathrow directly contributed £158 million to GDP as well supporting 3,200 jobs and generating £37 million in tax revenue. There are further indirect contributions to the economy such as workers spending their earnings. Taking into account both direct and indirect impacts, they give a conservative estimate of £342 million in value added, supporting 6,600 jobs and contributing £64 million in tax revenue. Night flights are of particular importance in connecting the UK with South East Asia. Heathrow handles 60% of freight, much of this is carried on passenger flights and may be time-sensitive. It is estimated that a ban on NQP flights would reduce UK GDP by £178 million per annum and job by 2,800, while a ban on all night flights would reduce UK GDP by £813 million per annum, and jobs by 11,900.

CE Delft – Ban on night flights at Heathrow Airport: A quick scan Social Cost Benefit Analysis (Korteland, M. and Faber, J., 2011)

This report assesses the costs and benefits of a night flight ban, identifying three extremes: all flights and connections rescheduled to daytime operations, all flights rescheduled to daytime operations but connections are lost, all night flights are cancelled. It is recognised that most responses would fall between these boundaries and therefore the costs and benefits will fall between the costs and benefits of these extremes. Based on these scenarios, it was found that the economic impacts are likely to fall within the range of an £860 million increase to a £35 million decrease, depending on the airline and passenger reactions to the ban. Oxford Economics (2011) questions the methodology of this study, suggesting that this research cannot be relied upon as a basis for policy analysis.

Other Studies of Aircraft Noise

Night flights and associated noise issues are not only a high-profile topic in the South-east England. This topic is also the subject of vigorous discussion in other parts of the UK as well as in other jurisdictions as summarised below.

The table below provides a snapshot of regimes in place at other major European Airports:

Table A1: Night-time curfews at Europe's major airports

Airport	Capacity [1]	Hours of Unrestricted Operation	General Ban on Night Time Flights
Amsterdam	108	06:00am - 11:00pm	No [2]
Paris CDG	97	06:00am - 11:15pm	No [2]
Copenhagen	83	06:00am - 11:00pm	No [2]
Munich	82	06:00am - 10:00pm	No, noise quota
London HLR	81	06:00am - 11:00pm	No, noise quota
Frankfurt	81	06:00am - 11:00pm	11:00pm - 05:00am
Madrid	78	06:00am - 11:00pm	No [2]
Milan	70	06:30am - 11:30pm	No [2]
Brussles	68	24h	No [2]
Zurich	**68**	**06:00am - 11:00pm**	**11:30pm - 06:00am**
Vienna	68	05:00am - 09:30pm	No [2]

Notes:

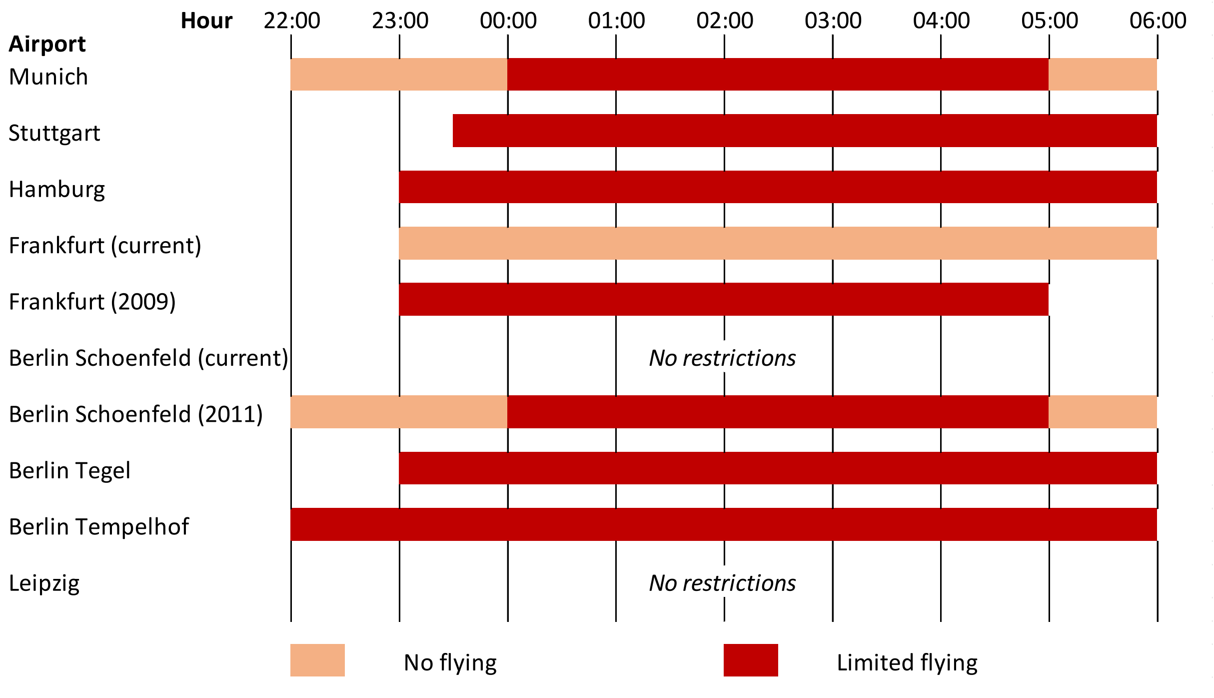
1. Movements / hour

2. Possible restrictions on the number of flight movements

German Airports

German Airports are also subject to a range of night flying restrictions as shown below. In some cases there are complete bans on night time movements in the core periods (e.g. Hamburg, Stuttgart), at others this is combined with some restriction of operations in the shoulders (e.g. Munich) and others like Berlin Schoenfeld and Leipzig there are none. The most controversial regime is Frankfurt Main, where there is a night-time movement ban between 11pm-5am.

Figure A1: Night flying restrictions at German airports



Swiss Airports[51]

There are 4 main airports in Switzerland: Geneva, Zurich, Lugano, Bern

- All are closed at night (12am -5am or 11pm - 6am)
- Additional restrictions apply after 9pm at both Geneva & Zurich (ZRH noise index<96EPN dB/<98EPNdB for long distance flights)
- NPRs, also preferential runways (Zurich)
- Compulsory use of FEGP and PCA: no engine run ups at night
- At Zurich, 2 runways closed for additional periods at weekends and (German) holidays as approach requires use of German airspace
- Noise surcharge based on deviation from mean noise value/time of day

ICAO: Working Paper on Night Flight Restrictions (October 2013)

ICAO reviewed the issue of night flight restrictions in 2013 and came to the following conclusions:

"*The issue of night curfews is linked to specific local situations, but has an impact on market access and the operation of international air services from other regions. As air traffic continues to grow, this issue will continue to exist. It would be difficult to develop a global solution as the situation varies from airport to airport and from State to State. An appropriate approach for States in aircraft noise management is to adopt the ICAO Balanced Approach, and to resolve difficulties with concerned States through available consultation and dispute settlement mechanisms.*"

It is notable, however, that Europe leads the way in terms of night flight restrictions with nearly two-thirds of the airports ICAO recorded as having such restrictions being from that continent.

European Commission – Assessing the Economic Costs of Night Flight Restrictions (February 2005)

This study assesses the economic importance of night flights in Europe and the economic costs of restrictions. It raises the following points:

[51] Geoff Maynard: A Global Review of Night Noise Regimes (October 2013)

- To optimise use of aircraft and crew for short-haul flights, there are large numbers of flights in the early morning and late evening.
- Long haul flights must wait for arrival of feeder flights before departure, and arrive in time for onward connections. A variety of factors lead to a large number of early morning arrivals of long haul flights.
- Some charter flights airlines require a turnaround during the night period to maximise aircraft utilisation.
- Businesses rely on Express carriers, whose business model requires being able to “hub” at an airport during the night.

CE Delft – Night Flight Restrictions and Airline Responses at Major European Airports (September 2012)

This report assesses the claims that night flights are essential for airline networks and provide important economic benefits. It says there is insufficient evidence as to whether night flights at Charles de Gaulle airport contribute to the French economy since studies available concentrate on benefits while ignoring costs. It suggests that economic impacts of airports and of night flights are often overstated since they ignore negative economic impacts such as tourist expenditures abroad and external effects of aircraft noise and air pollution. It also claims that studies focus on average effects e.g. value added per million passengers, rather than marginal effects which are likely to be smaller. It highlights differences between airports with and without night restrictions, saying that airlines adapt to the restrictions and use night flights for different purposes.

Bureau Veritas for Thanet District Council – A review of Night Quota Schemes at other UK airports (Nov 2010)

This examines a selection of non-London airports and provides a factual report on those that have some form of night noise control regime and those that don’t. For airports in the former category there is a description of each scheme with some like Bristol and Bournemouth relying on a London style of quota scheme, others like Southend limits numbers of specified aircraft types, while Doncaster Finningley sanctions aircraft flown more noisily than their certification would imply. Airports without formal noise quota restrictions do however seem to levy a surcharge for night flying (e.g. NEMA and Luton).

APPENDIX B: STAKEHOLDER INTERVIEW SUMMARIES

This Appendix provides key findings of 11 stakeholder interviews. More detailed information from the interviews, and key findings from a twelfth organisation interviewed, have not been provided because some of the information was deemed to be confidential.

Organisation: CAA **Date of Interview:** 9/12/15
Key Discussion Findings
• **Key costs incurred to airports for more night flights:** Having to provide services in relation to safety provision and the regulated side of the business such as making sure you have correct firefighting provision, air traffic control services in place. • **Key financial impact on passengers of more night flights:** Price rises due to lack of capacity at airports would be lower – if increased night flights add more capacity and may limit price growth. As demand increases to fill the extra capacity made available prices will rise, but less than they otherwise would do. • **Operational implications of fewer flights in core night period:** If airports did find a cost associated with keeping the airport open that was not outweighed by the benefits of flight revenue then they may be able to charge remaining flights more in order to cover this cost. • **Operational implications of increased flights in core night period:** Given how full Heathrow is, if you were to create extra slots in the night period you may get more benefit from retiring one or two flights from the key points of the day to reduce congestion than simply filling them all up with extra flights. • **Banning noisy aircraft in shoulder period:** Five years may not be enough time to replace all the noisiest aircraft in an airline's fleet… one option would be for airlines to move their quieter aircraft to the shoulder period and operate their noisier aircraft in their remaining slots. • **Implications for impacted communities:** There is likely to be a benefit to noise impacted communities in reducing night flights, and vice versa a disbenefit in increasing them. Similarly, there is likely to be a reputational benefit to the airport in cutting night flights. The latter is harder to quantify, but with noise contours, the impact on communities could be monetised.

Organisation: DHL

Date of Interview: 11/12/15

Key Discussion Findings

- DHL operate a large commercial operation at Heathrow, primarily by using the belly hold on passenger flights, but they also have two of their own aircraft which depart just before 11pm. Some of DHL's goods that come into the UK go onto other locations throughout the world, thus Heathrow is important because it provides the commercial hub which they require.

- Luton acts as a remote runway of Heathrow for DHL's two freighters because of the limitations on night flights at Heathrow. DHL freighters arrive into Luton in the early hours, and freight is moved by road between Luton and Heathrow for sorting and onward flights.

- DHL use the belly hold of one flight at Gatwick and do not operate from Stansted.

- DHL would welcome extra capacity for passenger airlines at Heathrow, particularly in the early mornings, as it gives more options for DHL customers. In addition, they would be able to offer later pick-ups in the origin country due to availability of the flights.

- DHL doesn't believe that long haul flights which arrive before 6am could be moved to after 6am because they are over night flights, so it would mean people leaving their origin at around 2am, and there is no market for such flights. Thus losing these flights effectively means that freight needs to wait for flights the following day, or flights to other destinations in Europe could be used, with onward traffic coming into the UK by road or air later in the day – with any of these scenarios freight will arrive at its destination a day late and thus the implications for UK PLC and competitiveness would be significant.

Organisation: EasyJet

Date of Interview: 11/12/15

Key Discussion Findings

- EasyJet are not currently looking to schedule more night flights, as departures before 6am are less popular with passengers. easyJet has very few over night flights and night flights are either flights that arrive after midnight or take off before 6am. However they consider that an increase in the number of allowed movements would help with resilience and resilience planning for the airport and the airlines.

- If the number of night flights were reduced, easyJet may respond by rescheduling flights, reducing their lines of flights, increasing the size of aircraft on some routes, and potentially reducing the number of destinations. Ultimately it would be likely to result in fewer flights, which would impact on the cost to the customer and reduced choice for the customer in terms of flight times and destinations.

- The economic costs incurred from flights scheduled in the night period are marginal, and are normally justified by the revenue and financial gains from increased utilisation of the aircraft. However costs incurred by aircraft which arrive beyond midnight due to late running aircraft are more significant because it affects the crew costs.

- All easyJet aircraft are quieter than QC2, and therefore a reduction in noise quotas is less likely to impact the airline than a reduction in movements.

Organisation: Gatwick

Date of Interview: 8/12/15

Key Discussion Findings

- Gatwick is getting close exceeding their permitted summer night movement quota. There is little flexibility for late running aircraft to return in the night and this now needs to be managed very carefully, on a daily basis.
- Gatwick believe that, based on ICF's independent analysis, there is demand from airlines for additional night time slots at the airport and therefore an increase in slots would enable airlines to grow. Gatwick believe that it would also increase passengers' choice in routes and times, increase competition between airlines and hence potentially decrease costs to passengers. An annual night movement quota would provide more flexibility for delayed flights to return during the busy summer season, but the environmental and noise impact of this would need to be considered.
- Reducing night movements would generate a significant loss in revenue for the airport. In addition to losing some rotations, there is a danger some whole lines of flight would disappear due to the multiple rotation business model of certain airlines operating at Gatwick, and that some airlines would move to other airports. This would have a major negative impact on the airport, passengers and regional employment.
- The costs of providing airport services to support more night flights is negligible – it would be less for arrivals and less if the flights are concentrated. Likewise the savings in costs from providing fewer services for fewer night flights is negligible.
- Night time noise quotas are less of an issue at Gatwick and are not so close to being exceeded. However, a reduction in movement quotas may be problematic.
- Data was provided on ACL annual data on summer season weekly pro rata usage and ACL annual data on summer season movements.

Organisation: Heathrow Airport

Date of Interview: 09/12/15

Key Discussion Findings

- Operating during the night period is crucial to the airport, in both maintaining a competitive advantage, in addition to being required to retain its position within the world hub ranking.

- Allowing more movements during the core night period would not result in significant operational or financial impacts as the airport is currently operating close to capacity, due to the imposed 480k cap. There would only be a small advantage in being able to build in a small amount of extra resilience into the flight schedule. If the cap were removed, there is enough demand to fill capacity.

- The early morning period is crucial for flight arrivals and restrictions here would impact the global network, due to the large volume of connecting flights. However, restrictions in the late evening period would also impact the rest of the flight scheduling, in order to avoid risking late departures.

- Restricting routes during the night period would have significant financial impacts because the route would need to be cancelled; there is no possibility of it moving to a day period as the airport is operating at capacity. Financial impacts would result in loss in revenue from the loss of the flight including: landing and parking fees; concession revenue; and revenue from retail outlets. There would be no financial gain as the volume of staff on duty would have to remain the same.

- Operationally, there is not the stand capacity to support the extra planes that would be required to park during the night period, as opposed to making another movement. There would be no operational benefits as the pressures on the day schedule would remain the same.

- The airport is currently operating well within the noise quota, so a significant reduction would need to occur to result in any noticeable impact. The impact would be felt more significantly by airlines, who would be required to operate quieter planes.

Organisation: NATS

Date of Interview: 9/12/15

Key Discussion Findings

- It must be recognised that flight activity is a global business, within this market airport scheduling will not be optimum without operators and schedulers coordinating the departure slots with the arrival slots around the world – this has implications for night flight timings at many global hubs. The current flight schedule does not offer a lot of flexibility to move flights later without a penalty.
- In isolation there are no air traffic control implications on an extra 10% of movements to Heathrow in the night period as there is no complexity in the arrival of that traffic (i.e. an increase from 16 to 18 movements prior to 0600).
- Larger increases could impact on staffing levels as more staff may be required during the night shift to service such a demand.
- Small decreases in flight movements would also not have a large impact on ATC, as it would not be enough to reduce staff manning levels. A more significant impact would result from a decision to totally remove all flights from the night period by finding methods by which to absorb them into the non-night operation.
- The answers in interview were from the perspective of NERL operational policy rather than from the perspective of the operational units.

Organisation: Ryanair **Date of Interview:** 1/12/15
Key Discussion Findings
• Ryanair's current model is based on a number of full rotations per day which, in order to keep aircraft fully utilised, relies on using the shoulder and core night period. • Ryanair have 40 based aircraft at Stansted and plan to have another 20 in the next 5 years subject to favourable conditions. They would therefore be able to utilise many more slots in the core night period, in particular in the first part of the night. Much of the growing market is medium haul, which particularly relies on the core night period. • A restriction on core night slots would prevent Ryanair from making full rotations. This would decrease the utilisation of the aircraft to an unacceptable level. They may therefore respond by basing the aircraft elsewhere, and flying into Stansted, or using the aircraft on other routes altogether. They will not respond by decreasing the utilisation of their aircraft. Ryanair consider that, given their current large market share at Stansted, and their lowest fares offer, pan-European presence and 200-airport network meaning that they are the most likely source of future development at Stansted, that this would have a significant negative financial impact on Stansted, and passengers would suffer loss of routes (as current routes may not be replaced by other airlines) and possibly increased fares. They also believe that restrictions on their Stansted operation could reduce the attractiveness of the airport to operators of potential new long haul routes, which may want to receive feed (transfer passengers) from Ryanair. • Ryanair suggests that priority for night slots should be given to airlines with the most passengers per flight, since a full aircraft makes the same noise as a half-empty one yet delivers a far greater economic benefit.

Organisation: Stansted Airport

Date of Interview: 09/12/15

Key Discussion Findings

- The low cost airline model run at Stansted by airlines including Ryanair and EasyJet rely on night time departures in order to be financially viable by making the required number of rotations per aircraft, per day. In addition, Stansted's positioning as a freight hub, means that cargo planes are reliant on using night slots in order to make next day delivery times.

- There is high demand from both passenger and freight airlines (not just at night) and Stansted is already examining ways to meet this demand through targeted expansion measures. Most increases in night movements would not result in material increases in costs as the majority (c70%) of airport costs are fixed. However, more night movements would result in significant increases in financial benefits due to the revenue generated from landing and parking charges and from retail outlets and car parking charges.

- Operationally, there would be very limited benefits to a reduction in night flight movements as the airport would still need to be resourced in the same way; some movements could be moved to the day period and the level hit of noise quota would be lowered. However, there would be very significant financial impacts that may result in loss of day movements in addition to the cancelled night movement in order for airlines to maintain their low-cost model of operations.

- The biggest impact would result from a restriction during the 2330 to 0000 period as significant numbers of passenger planes return and cargo flights depart during this timeframe.

- A reduction in the noise quota would not have a large impact on the airport, as caps on movements would be hit before the noise quota was exceeded. The impact on QC restriction would impact airlines more than the airport.

Organisation: Thomas Cook

Date of Interview: 8/12/15

Key Discussion Findings

- Thomas Cook could fill more night slots, but only if these are departures in the morning shoulder period (there is no demand for earlier flights) and arrivals towards the beginning of the night period. There would need to be more slots available in the day as well to enable 2 rotations to mid haul destinations a day.

- Thomas Cook rely on flights in the night period to make their programme work. Their programme from Gatwick relies on around 16 hours flying and around 4.5 hours of turn-around time to enable them to undertake 2 rotations to mid haul rotations a day. Running one rotation a day is not sustainable – the increase in cost would be unviable with current competition which has more flexibility on short haul and domestic routes. Other UK airports are unsuitable alternatives as they serve a different market, or have too short a runway. They do not have the flexibility to mix short and long haul rotations because they do not have slots at short haul destinations and this is not where their market is growing; low cost carriers now predominate in the short haul market.

- A key cost of operating flights which arrive close to the night time period is the penalties incurred if there are small delays, resulting in the flight being re-scheduled for the following day in order to avoid it arriving during the night period – this occurs in Frankfurt. If this also occurred in the UK because a lack of night slots meant less resilience, this would create big problems for them.

- If reducing the noise quota at night meant Thomas Cook lost a night slot, this would have the same impact as a reduction in the number of movements. A ban on QC2s at night or QC4s in the shoulder period would also have the same effect if this affects their flights. They would not be able to move smaller planes to operate out of Gatwick because they need the capacity of larger planes on those routes.

- Thomas Cook consider that the night flight regime should remain unchanged in 2017. They also consider that no decision about change should take place in advance of construction of any additional runway which will provide extra capacity to replace that lost by restricting night flights.

Organisation: UPS Europe **Date of Interview:** 11/12/15
Key Discussion Findings

- UPS currently has 6 movements a week at Stansted in the core night period and 5 in the shoulder period. This increases by 4 movements a week in the peak season. They do not operate in Gatwick and use some belly hold for operations in Heathrow.

- Cologne is the UPS European hub. From Cologne they go transatlantic and to the East. Most of UPS's flights from Stansted are either going to/from Cologne or direct to/from the USA.

- UPS do not currently require more night movements for their own aircraft operations but as the economy grows they are likely to require more in the future. More night movements now would, however, provide greater resilience. Stansted is getting closer to filling its quota which does not allow much room for growth if required. Due to the nature of their business the times of additional night flights would need to be flexible.

- The cargo industry is reliant on night flights to achieve overnight deliveries on-time the following morning. If there is a decrease in movements UPS would have to find another airport from which it could service customers in London and the south east of England. This would be a challenge as the runway at Luton is too short and Heathrow is capacity constrained. The other option would be to operate out of East Midlands, which would be less reliable, with more service failures, and hence compensation for late deliveries would be a more frequent occurrence.

- If the noise quota was reduced they would either have to find an alternative airport (which, as highlighted above, would be a challenge) or operate a larger number of smaller aircraft, which would necessitate more movements, additional cost and be much less efficient.

- However, all these options would potentially increase costs, ultimately to the customer.

Organisation: Virgin **Date information provided:** 11/01/2015
Key Discussion Findings
• Virgin operate a very limited number of night flights at Heathrow and Gatwick, with one from Hong Kong to Heathrow and a limited number of early morning flights to Gatwick inbound from the Caribbean. • The departure time of their Hong Kong flight is in direct response to strong consumer demand for an overnight flight with a pre-midnight departure and an early morning arrival time, allowing business travellers to do a full day's work in London or to catch connecting flights from Heathrow. • Given the capacity constraints at Heathrow Virgin would likely make use of additional capacity at the airport in the early morning period, if it were to be made available. • Early morning arrival slots are particularly suitable for services from emerging economies in the Far East, Africa and South America. • Virgin has now placed a B787-9 on its HKG operations which is currently the quietest aircraft to operate during this time. By the end of the decade its LHR fleet will consist entirely of A330-300 and B787-9 aircraft, resulting in a significantly reduced noise output.

APPENDIX C: TEST POLICY SCENARIOS

Unless stated otherwise, the changes to the movement and noise quota limits in each season under each test scenario below are applied immediately from the beginning of the Winter 2017/18 and Summer 2018 seasons. The current movement and noise quota limits are applied in earlier seasons under all of the scenarios below.

Scenario Label	Aircraft Movements	Noise Quota
Counterfactual		
U	Current Night Flights Regime Unchanged	
	Tightening of Current Night Flights Regime	
Restrictive Scenarios		
R1	No Change to Movement Limits	Noise quota limits in each season reduced to 10% below the total Quota Count of night flights during the NQP in the season in 2014/15
R2	No Change to Movement Limits	Noise quota limits in each season reduced to 30% below the total Quota Count of night flights during the NQP in the season in 2014/15
R3	No Change to Movement Limits	Noise quota limits in each season reduced to 50% below the total Quota Count of night flights during the NQP in the season in 2014/15
R4	10% fewer flights allowed in each season during the NQP	10% reduction in noise quota limits in each season
R5	30% fewer flights allowed in each season during the NQP	30% reduction in noise quota limits in each season
R6	50% fewer flights allowed in each season during the NQP	50% reduction in noise quota limits in each season
R7	No flights allowed during the NQP	No noise quota
R8	No Change to Movement Limits	No flights allowed during the NQP by aircraft with a Quota Count of 4 or above

	Counterfactual	
U		Current Night Flights Regime Unchanged
	Relaxation of Current Night Flights Regime	
Loosening Scenarios		
L1	Movement limits in each season increased each year to allow 50% of the additional demand for night flights above the current movement limits during the NQP	No change to noise quota limits
L2	Movement limits in each season increased each year to allow 100% of the additional demand for night flights above the current movement limits during the NQP	No change to noise quota limits
L3	Movement limits in each season increased each year to allow 50% of the additional demand for night flights above the current movement limits during the NQP	Noise quota limits in each season reduced to equal the total Quota Count of night flights during the NQP in the season in 2014/15
L4	Movement limits in each season increased each year to allow 100% of the additional demand for night flights above the current movement limits during the NQP	Noise quota limits in each season reduced to equal the total Quota Count of night flights during the NQP in the season in 2014/15
L5	Movement limits in each season increased each year to allow 100% of the additional demand for night flights above the current movement limits during the NQP [High sensitivity of demand for night flights]	Noise quota limits in each season reduced to 50% below the total Quota Count of night flights during the NQP in the season in 2014/15
L6	Movement limits in each season increased each year to allow 100% of the additional demand for night flights above the current movement limits during the NQP [High sensitivity of demand for night flights]	Noise quota limits in each season increased each year by the same percentage as the movement limits

Notes:

1) The reductions in the noise quota limits under the Restrictive Scenarios R1 to R3 are assumed to be implemented linearly over the first 5 years of the 10 year modelling period (e.g. Under R1, the noise quota limit in a season would be reduced to 2% below the total Quota Count of night flights during the NQP in the season in 2014/15 in the first year, 4% in the second year, 6% in the third year, 8% in the fourth year and 10% in the fifth year).

2) For Loosening Scenarios L1 to L6, the additional demand for night flights referred to here is airport, season and year specific. Thus, for example, if the demand for night flights during the NQP at an airport in a season is 14,000 night flights in a given year and the current movement limit is 11,000 night flights under the counterfactual, the additional demand for night flights during the NQP would be 3,000 night flights. Increasing the movement limit to allow 50% of the additional demand for night flights above the current movement limit during the NQP would require the movement limit to be raised by 1,500 nights flights (i.e. 50% of 3,000) to a total of to 12,500 night flights (i.e. 11,000 + 1,500).

3) For the high sensitivity of demand for night flights in Scenarios L5 and L6, the demand for night flights during the NQP in each season is arbitrarily increased by 25% linearly over the 10 year modelling period compared to the default levels in the model (i.e. an increase of 2.5% in year 1, 5% in each year 2, 7.5% in year 3, 10% in year 4, 12.5% in year 5, 15% in year 6, 17.5% in year 7, 20% in year 8, 22.5% in year 9 and 25% in year 10). For example, if the demand for night flights during the NQP at an airport in a season is 14,000 night flights in year 10, arbitrarily raising the demand for night flights by 25% would imply assessing a scenario where the demand for night flights during the NQP is 17,500 flights in year 10 (i.e. 14,000 + 3,500).

4) The current movement limit is the movement limit in the counterfactual.

5) The current noise quota is the noise quota in the counterfactual.

APPENDIX D: QUALITY ASSURANCE PROCEDURES

Processes for the Model Control Environment

Process	Sub-Process	Action	QA Checks Undertaken
Access Control	Access restricted to a need to know basis	Model development undertaken by core team set out in SYSTRA's proposal. No other staff will have access to the model.	A "Confidential" project folder has been set up on SYSTRA's network drive. All model files are kept in this folder. Only the following SYSTRA staff have access to this drive: Richard Hancox, Stephen Heritage, Rafael Maldonaldo & Nicola Troll.
	Population with access to models broadly represents users	*Not applicable*	*Not applicable*
Change Control	Changes are subject to a proportionate approvals process before they are made	Changes can only be made by the core team mentioned above. All significant changes to be approved by Project Director (Richard Hancox) or Project Manager (Stephen Heritage).	All significant changes have been approved by either Project Director (Richard Hancox) or Project Manager (Stephen Heritage).
	Controls in place to prevent unauthorised or accidental changes	Access restricted to core team.	Access restricted to the four SYSTRA staff named above.
Version Control	Keeping a control log of versions and changes made	Version control register will be kept, logging all changes along with version number.	This has been done.
	Naming conventions and version numbers	See above.	See above.
Back-Up and Recovery	Models are located on IT approved infrastructure with back-up and recovery processes	Models developed on official SYSTRA authorised software. Models will be saved on a separate password-protected section of the secure SYSTRA server.	Models have been developed on official SYSTRA authorised software. See comment above re. access and security.
	Previous operational versions of the model are kept in restricted areas to prevent changes to historic records	These could be kept in the same separate area of our server, with appropriate version control.	This has been done.
Single Person Dependency	Consideration of whether more than one person should be skilled in the development and use of the model	All of the core team will be familiar with the basics of the model and the calculations will be transparent.	The staff named above are familiar with the basics of the model.
User Guide and Succession Planning	Existence of a user guide for the models	A simple accessible user guide to the models that is understandable by DfT staff with basic Microsoft Excel knowledge will be prepared and provided to the DfT. The user guide will contain: a) An accessible description of the models, including the structure of the models, the purpose of each sheet in the models and what each variable in the models means; b) Guidance for the model user on how to run the models in order to estimate the impacts of a policy scenario and make use of other functionality (e.g. how the model user can change the Input Data in the models) c) An accessible description of the analysis used to aggregate the raw data input into the flight groupings used in the models; and d) Guidance for the model user on how to amend the analysis used to aggregate the raw data input into the flight groupings used in the models (e.g. how to aggregate the raw data into data into different flight groupings).	A User Guide meeting the specified criteria has been provided to DfT.
	Consider succession planning	*Not applicable*	*Not applicable*

Documentation Standards	Data, methods, assumptions and parameters in the model are documented	An expanded version of the Excel Model Note (already prepared) will be provided as a record of these.	Data, methods, assumptions and parameters in the model are documented in this report and in the User Guide.
	Model developers and users are trained in the modelling tools, techniques and controls	SYSTRA will employ experienced analysts in the development of the model. The model will be designed to be useable by those with basic MS Excel skills.	SYSTRA has employed highly experienced analysts in the development of the model. The model has been designed to be useable by those with basic MS Excel skills, as far as is possible.
Skills and Experience	Understanding of how modelling suite fits together	There is no modelling suite as such. The Model Excel Note mentioned above will describe how the raw data, which is processed offline, is input to the model.	This report and the User Guide mentioned above describes how the raw data, which is processed offline, is input to the model.
	Previous operational versions of the model are kept in restricted areas to prevent changes to historic records	*Not applicable*	*Not applicable*

Processes for Model Accuracy and Reliability - Model in Development

Process	Sub-Process	Action	QA Checks Undertaken
Developed in line with model life-cycle	All stages of the model life-cycle are considered and appropriate time is given to each stage: model specification, build and test	Considerable time has already been spent on the specification of the model. Model building and testing will be carried out intensively over a period of around one month.	Significant time and effort has been spent on model building and testing
	Consideration of alternative approaches	*Not applicable*	*Not applicable*
Input Validation	Measures to check accuracy and reliability of input data	Raw data to be obtained from official industry-recognised sources. Reliability / accuracy checks to be undertaken by core team.	Raw data has been obtained from official industry-recognised sources, checked and (where appropriate) passed to DfT.
	Log of all inputs and sources	Will be recorded in the Excel Model Note.	This is provided in the User guide..
	Inputs and assumptions are signed off	All key inputs and assumptions to be signed off by Project Director or Project Manager.	This has been done.
Developer Testing	Review of all unique formulae or use of audit software	An independent SYSTRA reviewer will examine all unique formulae and undertake a detailed review of the calculations.	The independent SYSTRA reviewer -Nicola Troll - has reviewed all unique formulae and has undertaken a detailed review of the calculations and model logic, and has done a walk-through of the model.
	A walkthrough of the model – checking and testing of code, formulae and linkages	Yes, independent SYSTRA reviewer will walk through model.	See above.
	A detailed review of model logic eg. checking the actual flow of data through the model against a stylised example of how data is perceived to be flowing through the model	Yes, independent SYSTRA reviewer will undertake a detailed review of model logic.	See above.
	Cross-check of model outputs against an alternative set of data or information	Alternative set of data not available. Sense checks will be undertaken.	Sense checks have been undertaken by both Richard Hancox and Nicola Troll.
	Parallel Model Build	*Not applicable*	*Not applicable*
	Parameters in the model are fitted to real-world data	Alternative set of data not available. Sense checks will be undertaken.	See above.
	Model forecasts are checked against observed information	*Not applicable*	*Not applicable*
Communication of Model Limitations and Uncertainty	Sensitivity testing of key model assumptions	Limited testing will be done as part of the testing of the various policy scenarios.	Limited testing has been done as part of the testing of the various policy scenarios once the models are finalised.
	Scenario testing of a group of model assumptions	As above.	As above.
	Communication of limitations	Model limitations to be specified in the Excel Model Note and Draft Final Report.	Model limitations are specified in the Final Report.
	Communication of model uncertainty	Model uncertainty to be specified in the Excel Model Note and Draft Final Report.	Model limitations are specified in the Final Report.
Independent Review	Review of model development or results by someone other than the developer – could take the form of any of the 'developer tests' or another agreed method.	Independent peer review of the model structure, flow and processes will be undertaken within SYSTRA.	The independent SYSTRA reviewer -Nicola Troll - has undertaken a review of the model structure, flow and processes. This is documented in the Final Report.
	High level sense-check	Sense checks of the plausibility of estimated impacts will be undertaken by the SYSTRA management team (Project Director and Project Manager) and Northpoint.	This has been done.

Processes for Model Accuracy and Reliability - Model in Use

Process	Sub-Process	Action	QA Checks Undertaken
Input Validation	Measures to check accuracy and reliability of input data	Raw data to be obtained from official industry-recognised sources. Reliability / accuracy checks to be undertaken by core team.	Raw data has been obtained from official industry-recognised sources, checked and (where appropriate) passed to DfT.
	Log of all inputs and sources	Will be recorded in the Excel Model Note.	This is provided as in the User Guide.
	Inputs and assumptions are signed off	All key inputs and assumptions to be signed off by Project Director or Project Manager.	This has been done.
Testing of Model Runs	Review of any changes since last, use, for example compare outputs to expected size or sign	*Not applicable*	*Not applicable*
	Parallel Model Run	*Not applicable*	*Not applicable*
	Cross-check of model outputs against an alternative set of data or information	Alternative set of data not available. Sense checks will be undertaken.	This has been done.
	Use of error traps or diagnostics	*Not applicable*	*Not applicable*
	Test convergence of iterating models	*Not applicable*	*Not applicable*
	Review of model parameters to ensure they remain fit for purpose	*Not applicable*	*Not applicable*
	Model forecasts are checked against observed information	*Not applicable*	*Not applicable*
	Automation of model run process	Model processing will be automated within Excel.	Model processing has been automated within Excel.
Communication of Model Limits and Uncertainty	Sensitivity testing of key model assumptions	Will be undertaken as part of the testing of policy scenarios.	Limited testing has been done as part of the testing of the various policy scenarios once the models are finalised.
	Scenario testing of a group of model assumptions	Will be undertaken as part of the testing of policy scenarios.	As above.
	Communication of limitations	Model limitations to be specified in the Excel Model Note and Draft Final report	Model limitations are specified in the Final Report.
	Communication of model uncertainty	Model uncertainty to be specified in the Excel Model Note and Draft Final report	Model limitations are specified in the Final Report.
Independent Review	Review of model results by someone other than the developer – could take the form of any of the 'developer tests' or another agreed method.	Independent peer review of the model structure, flow and processes will be undertaken within SYSTRA.	The independent SYSTRA reviewer -Nicola Troll - has undertaken a review of the model structure, flow and processes. This will be documented in the Final Report.
	High level sense-check	Sense checks of the plausibility of estimated impacts will be undertaken by the SYSTRA management team (Project Director and Project Manager) and Northpoint.	This has been done.

Processes for Governance and Transparency

Process	Sub-Process	Action	QA Checks Undertaken
Governance	Shared understanding of modelling requirements between analyst and policy partner	Extensive discussions have already been held regarding the purpose and specification of the model.	Extensive discussions have already been held regarding the purpose and specification of the model.
	Procedures in place for the flow of information	Good communications established between consultancy team and DfT.	Good communications established between consultancy team and DfT.
	Clear process for the internal challenge of results	Northpoint and the SYSTRA management team (Project Director and Project Manager) will sense check and challenge integrity of results	This has been done.
	Clearance of results from the SMO	*Not applicable*	*Not applicable*
	Uncertainty in the modelling output is conveyed to decision-makers	Model uncertainty to be specified in the Excel Model Note and Draft Final Report.	Model uncertainty is specified in the Final Report.
	Fitness for purpose of model under periodic review	*Not applicable*	*Not applicable*
Transparency	Results are in the public domain	Yes. Results will be sense checked before incorporation into any reports that will be in the public domain.	This has been done.
	Model exposed to external challenge through stakeholder engagement, report publication, planning inquiry system, judicial review	Northpoint will review the suitability of the model inputs and the credibility of the outcomes predicted by the model. Peer review by a party outside the SYSTRA/Northpoint team to establish the robustness of the model to external challenge.	Northpoint review of the suitability of the model inputs has been done. Peer review by Richard Bullock has been undertaken.
	Methods are in the public domain	See above.	See above.
	Useable model is in the public domain	*Not applicable*	*Not applicable*
	Model not in public domain but perform model runs for stakeholders.	*Not applicable*	*Not applicable*

APPENDIX E: PEER REVIEW

Night Flights Aviation Research Study

A review

INTRODUCTION

This paper reviews the draft final report on the Night Flights Aviation Research Study as it existed at end-October 2016. To assist in the review a version of the model was also provided to illustrate the descriptions in the report but this review has not audited the model in any way. Following a series of discussions with the consultants some modifications were made to the passenger demand submodel as originally formulated together with the associated calculation of economic benefits. The review of this part of the work relies on the draft report together with subsequent clarifications and modifications by the consultants.

The objective of the study is to investigate the impacts of possible changes to the night flights regime on airports, airlines, passengers and public accounts, with particular regard to Heathrow, Gatwick and Stansted, and to produce a flexible methodology which can be used by the Department to assess the economic impacts of any changes to the current night flights regime on these groups.

In terms of providing a methodological framework, the project appears to have achieved its objective. However, the project was originally planned to be completed within 10 weeks and this is a very short time in which to develop and fully test the behavioural and operational responses which are at the heart of this work, given the very limited research that has previously been undertaken. The model is complete in that it includes a set of such responses but there could be further work done, as discussed at the end of this review, to further develop and refine them. Note that this does not require wholesale reconstruction of the model, merely the substitution of one set of responses by another.

Flexibility is another issue. The main use of a model should be to test hypotheses and sensitivities and the best models are able to provide insights through extensive testing of changes in the various input variables. This can only be done in this reviewer's experience if the model runs quickly and enables, say, half-a-dozen alternatives to be examined in one session. This was not possible with the model provided to the reviewer due to the excessive runtime. This issue is further discussed in the next section.

It is also worth mentioning that although DfT already has a comprehensive set of aviation demand models, none of them address the specific issues covered in this study and few of the various parameters used in these models are relevant in this case.

The remainder of this review considers in turn the overall structure of the model, the current assumptions concerning the passenger and cargo response to changes in flight timing, the calculation of economic benefits and the various input parameters adopted. This review has been done under considerable time pressure and has inevitably had to focus on the key issues as the reviewer sees them. It has not attempted to check every input but instead has concentrated on the overall reasonableness of the approach and the sample results provided.

OVERALL MODEL STRUCTURE

The model structure is relatively simple in concept, although rather unwieldy in its implementation, due to the very detailed analysis required by DfT. This results in a very large model by most standards, some 60 Mb, with accompanying penalties in terms of run time. The version used by this reviewer took well over an hour to run, on a fast laptop. The real problem is probably the time taken to write the results of the various calculations to the individual sheets; whether this needs to be for each of the ten years is debatable in the view of this reviewer and reducing the analysis to, say, three years (beginning, middle and end) would probably reduce the run time by 70% with little impact on the conclusions. A version covering only a single year would probably be even more useful in understanding sensitivities and the relative significance of the various assumptions. This should be seriously considered by DfT, unless they have access to a really fast computer, as otherwise there will be only limited opportunities for undertaking the exploratory 'what-if' questions that are important when using models to help formulate policy.

The model is designed to address two sets of responses to restrictions on night flights:

- The response of the airlines in terms of which flights they reschedule or cancel
- The response of passengers to these changes made by the airlines.

The model does not attempt to mimic the airline response. Instead this is selected at the start of the model run. As it stands, it appears the options involving alternative airports assume the airline would relocate either to an alternative UK airport or to an overseas airport. The first of these is plausible (e.g. Emirates flies into both Gatwick and Heathrow from Dubai) but the second seems unlikely. But it is important to recognise that even if the airline decides to stay at, say, Heathrow with a later arrival time, passengers may decide to go via another airport with another airline.

In order to implement the assumed airline response, the model contains data on all arriving /departing flights during the night quota period including their route type, average load and cost and revenue (and hence profitability). The reviewer understands this data was provided to the consultants and this review has not attempted to verify its validity. The remit of this peer review does not include a review of this input data.

PASSENGER AND CARGO RESPONSES

The heart of the model is the assumed responses of passengers and to changes in the flight schedules (see Chapter 4 of the report). Key elements are summarised below with comments by the reviewer.

Airline response	Passenger response	Comment
Constrained flights lost	Demand reduced in line with change in capacity: Passenger numbers factored down in proportion to reduction in supply	Passengers may transfer to later flights with other airlines who then use larger aircraft
Rescheduling flights to shoulder	Proportion of unconstrained night period passengers will be deterred from travelling on this flight	May divert to other airports
Rescheduling the flights to shoulder requiring displacement of the shoulder flight schedule	Demand for displaced flights reduced in line with change in capacity; passenger numbers factored down in proportion to reduction in supply	Some passengers from rescheduled flight may also divert to other airports
Passengers re-routing to another UK Airport	Proportion of OD passengers which will 'relocate' identified by modelling the impact of an additional surface access travel time will impact demand. Transfer passengers from the night period assumed lost	Some passengers will also divert to other carriers in the shoulder at original airport, with subsequent impact on aircraft size
Passengers transferring to existing flights via another non-UK Airport	Proportion of OD passengers which need to transfer elsewhere identified using a transfer penalty and extended travel time. Transfer passengers assumed lost	As above, some passengers will stay at original airport but transfer to other airlines in shoulder

Modelling passenger responses clearly provides opportunities for extreme complexity in any particular instance. Identifying the practical options available to individual groups of passengers will be a major task, magnified considerably by the model’s current requirement for this to be done on a bi-annual basis for ten years.

In the reviewer’s opinion the most practical approach is to use a choice model, with generalised parameters rather those specific to any one group of flights at any particular arrival time. Such a model could be a relatively simple multinomial model or a more complex nested model with a hierarchy of choices. It is clearly unrealistic to expect the final forms of such models to be developed within a relatively short research project, such as this one, as they are typically based on either stated preference or revealed preference data, little of which is readily available to the study.

Based on consultations with the consultants, the model currently uses a single-level multinomial logit model in which the choices are characterised by standard variables such as access/egress time and cost, wait time, in-flight time etc. Variations in these characteristics are converted into choice probabilities using an incremental choice model (thus avoiding the need to determine choice-specific constants). This is a sensible initial approach which also allows plenty of scope for refinement as further research is undertaken.

The study participated in several discussions with the air freight industry. The consistent view expressed at these meetings was that, as far as the air freight industry itself was concerned, delivery times to the customer had the greatest importance and if arrivals at any given airport (and especially Heathrow) were delayed until later in the morning this would have a serious impact on their ability to provide a competitive service. Accordingly, they would move from the airport in question to another UK airport which could accommodate them or, failing that, to a non-UK airport close to UK such as Schipol and deliver from there by road.

The industry view was that any such changes would not have a material impact on their businesses as any changes in costs would be reflected in the amounts they charged customers. The model as constructed reflects these opinions, with changes in the night flight regime having limited impact on the air cargo industry. However, there almost certainly will be an impact on shippers and customers and it is suggested these results need to be carefully defined and explained if the model is to be subject to external scrutiny.

CALCULATION OF ECONOMIC BENEFITS

The economic benefits are presented as the sum of:

- Airline costs and benefits
- Passenger costs and benefits
- Airport costs and benefits
- Public Accounts costs and benefits

The airline costs and benefits are calculated directly from the unit revenues and unit costs of the affected flights. This data has been provided by an industry specialist and this reviewer offers no opinion on its quality. As discussed with the consultant, the main issue that needs care is whether or not to include the fixed component of aircraft operating cost if a flight is cancelled. For some categories of flights, such as short-medium distance holiday flights, the business model relies on maximizing the number of rotations that can be achieved with each aircraft; if this is reduced, the operator can only provide the same capacity by buying additional aircraft. Where, however, a flight is merely shifted in time without any significant implications for fleet size, as is the case with many long-haul flights to and from the Far East, the fixed component should not be included in the cost calculations.

Based on discussions with the consultants, the passenger benefits are based on the change in composite cost of the underlying logit model (commonly known as the logsum). This is a standard approach to evaluating the benefits of a change in choices. The consultants also indicated these benefits included a shadow cost associated with the night flight constraints; this was explained as being consistent with the Webtag guidance on aviation. This reviewer is in no position to comment on this, as he has had no occasion to use this guidance.

The airport costs and revenues are calculated as the product of changes in passenger volume and unit revenues and costs. Again, the unit costs have been provided by industry experts.

The change in public accounts is also calculated directly as the product of changes in passenger volume, unit spends by passengers and in air passenger duty. As with the passenger economic benefits, the public accounts includes a component associated with the shadow price included in the passenger benefits. Again, this reviewer cannot comment due to lack of familiarity with the concepts.

INPUT PARAMETERS

The model requires many parameters for such travel characteristics as business:leisure splits, features of transfer passengers and travel time to alternative airports as well as for behavioural parameters such as value of time. It is clearly beyond the scope of this study to undertake fundamental research into many of these. The values adopted to date seem reasonable but all could be progressively refined by further research.

FURTHER DEVELOPMENT

DfT is strongly urged to develop a cut-down version of the model, preferably covering a single year, in order to test the significance of changes in particular variables and inputs. Even if DfT has access to high-powered computing facilities, it is doubtful if many third parties would who would have an interest in the model. It is inevitable that a model of this type will need to make many assumptions on passenger behavior pending further research and any conclusions will need to be tested against a range of input parameters. This will be very difficult unless the run-time is kept to a reasonable level.

A second area of development would be to analyse available passenger surveys, such as the CAA surveys, to improve the various input assumptions, especially concerning transfers and flights already being undertaken indirectly via a non-UK airport.

Finally, the methodology rightly has a choice model at its heart. Thus far it has been calibrated, as are many choice models, using some available sources combined with a large component of expert judgement. If the model is to be further developed, priority should be given to validating the current choice model parameters by undertaking some stated preference surveys of current air passengers, ideally those who arrive in the early mornings. This would enable the choices considered by passengers to be more closely defined as well as providing a better basis for predicting the choices which are actually made.

APPENDIX F: SUMMARY MODEL RESULTS - POLICY SCENARIO TESTS L1 TO L4 AND R1 TO R8

Except where noted, the Total Impacts shown in the following table are relative to the Baseline scenario. The Total Impacts are calculated over the 10 year modelling period (2017/18 to 2026/27), are undiscounted and do not include the impacts on non-commercial flights.

	Gatwick				Heathrow				Stansted			
Impacts relative to the Baseline scenario (10 year assessment period, undiscounted)	Night Operations	QC	Minimum Total Impacts (£m)	Maximum Total Impacts (£m)	Night Operations	QC	Minimum Total Impacts (£m)	Maximum Total Impacts (£m)	Night Operations	QC	Minimum Total Impacts (£m)	Maximum Total Impacts (£m)
Unconstrained												
Unconstrained	168,664	71,480			55,030	35,827			148,940	96,700		
Baseline												
Baseline	135,300	57,209			54,171	35,240			122,510	78,561		
Loosening Scenarios												
L1 Test Scenario: Movement limits in each season increased each year to allow 50% of the additional demand for night flights above the current movement limits during the NQP. No change to noise quota limits.	153,222	64,882	89	318	54,782	35,649	4	18	124,089	79,600	6	10
L2 Test Scenario: Movement limits in each season increased each year to allow 100% of the additional demand for night flights above the current movement limits during the NQP. No change to noise quota limits.	163,222	69,119	125	465	55,026	35,824	6	24	124,089	79,600	6	10
L3 Test Scenario: Movement limits in each season increased each year to allow 50% of the additional demand for night flights above the current movement limits during the NQP. Noise quota limits in each season reduced to equal the total Quota Count of night flights during the NQP in the season in 2014/15.	133,297	56,182	-37	2	54,782	35,649	4	18	101,675	62,910	-84	-39
L4 Test Scenario: Movement limits in each season increased each year to allow 100% of the additional demand for night flights above the current movement limits during the NQP. Noise quota limits in each season reduced to equal the total Quota Count of night flights during the NQP in the season in 2014/15.	133,297	56,182	-37	2	55,026	35,824	6	24	101,675	62,910	-84	-39
Restrictive Scenarios												
R1 Test Scenario: No Change to Movement Limits. Noise quota limits in each season reduced to 10% below the total Quota Count of night flights during the NQP in the season in 2014/15.	123,001	51,688	-241	-65	54,171	35,240	0	0	94,532	57,877	-132	-64
R2 Test Scenario: No Change to Movement Limits. Noise quota limits in each season reduced to 30% below the total Quota Count of night flights during the NQP in the season in 2014/15.	102,409	42,699	-731	-186	54,171	35,240	0	0	80,244	47,812	-242	-114
R3 Test Scenario: No Change to Movement Limits. Noise quota limits in each season reduced to 50% below the total Quota Count of night flights during the NQP in the season in 2014/15.	81,816	33,709	-1,334	-298	49,843	32,470	-191	-51	65,957	37,746	-360	-149
R4 Test Scenario: 10% fewer flights allowed in each season during the NQP. 10% reduction in noise quota limits in each season.	124,100	52,438	-224	-62	51,621	33,538	-111	-55	111,467	70,612	-54	-33
R5 Test Scenario: 30% fewer flights allowed in each season during the NQP. 30% reduction in noise quota limits in each season.	101,700	42,897	-764	-195	41,909	27,020	-580	-277	89,283	54,646	-194	-105
R6 Test Scenario: 50% fewer flights allowed in each season during the NQP. 50% reduction in noise quota limits in each season.	75,648	31,540	-1,513	-333	30,309	19,258	-1,187	-475	66,932	38,562	-377	-167
R7 Test Scenario: No flights allowed during the NQP. No noise quota.	0	0	-3,737	-517	0	0	-4,550	-483	0	0	-798	-130
R8 Test Scenario: No Change to Movement Limits. No flights allowed during the NQP by aircraft with a Quota Count of 4 or above	135,300	57,209	0	0	54,129	35,001	2	2	123,079	78,192	-2	0
R5b Test Scenario: 30% fewer flights allowed in each season during the NQP. 30% reduction in noise quota limits in each season. [Low sensitivity elasticities]. [Note - The Total Impacts shown for this scenario are relative to Scenario R5 above.]	101,700	42,897	-68	-8	41,909	27,020	-10	17	89,283	54,646	-22	-7

Source: Sheet O_TotalSummary

APPENDIX F: SUMMARY MODEL RESULTS - POLICY SCENARIO TESTS L5 & L6 (COMPARED AGAINST HIGH GROWTH SCENARIO)

The Total Impacts shown in the following table are relative to the High Growth Baseline scenario. The Total Impacts are calculated over the 10 year modelling period (2017/18 to 2026/27), are undiscounted and do not include the impacts on non-commercial flights.

	Gatwick				Heathrow				Stansted			
	Night Operations	QC	Minimum Total Impacts (£m)	Maximum Total Impacts (£m)	Night Operations	QC	Minimum Total Impacts (£m)	Maximum Total Impacts (£m)	Night Operations	QC	Minimum Total Impacts (£m)	Maximum Total Impacts (£m)
Unconstrained												
Unconstrained - High growth	192,803	81,736			62,564	40,541			169,188	109,971		
Baseline												
Baseline - High growth	138,701	58,565			57,982	37,560			123,763	78,561		
Loosening Scenarios												
L5 Test Scenario: Movement limits in each season increased each year to allow 100% of the additional demand for night flights above the current movement limits during the NQP [High sensitivity of demand for night flights]. Noise quota limits in each season reduced to 50% below the total Quota Count of night flights during the NQP in the season in 2014/15.	69,434	28,091	-1,618	-369	45,331	28,932	-618	-141	58,832	31,455	-470	-156
L6 Test Scenario: Movement limits in each season increased each year to allow 100% of the additional demand for night flights above the current movement limits during the NQP [High sensitivity of demand for night flights]. Noise quota limits in each season increased each year by the same percentage as the movement limits.	192,760	81,718	257	1,031	62,559	40,537	89	193	164,440	106,269	125	208

Source: Sheet O_TotalSummary